This document was too large to scan as a single document. It has been divided into smaller sections.

SECTION 2 OF 3

Document Information			
Document #	**DOE/RL-2004-24**	**Revision**	**DRAFT A**
Title	**FEASIBILITY STUDY FOR THE 200-CW-5 (U-POND/Z-DITCHES COOLING WATER WASTE GROUP) & 200-CW-2 (S-POND & DITCHES COOLING WATER WASTE GROUP) & 200-CW-4 (T-POND & DITCHES COOLING WATER WASTE GROUP) & 200-SC-1 (STEAM CONDENSATE WASTE GROUP) OU [DRAFT A REISSUE]**		
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CHAPTER 7.0 TERMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
ERDF	Environmental Restoration Disposal Facility
OU	operable unit
PRG	preliminary remediation goal

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7.0 COMPARATIVE ANALYSIS OF ALTERNATIVES

This chapter presents the comparative analysis of the six remedial alternatives for the 200-CW-5 Operable Unit (OU), 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites to identify their relative advantages and disadvantages. This comparison is based on the seven *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) evaluation criteria discussed in Chapter 6.0. The results of this analysis provide a basis for selecting a remedial alternative for each representative waste site and associated analogous waste sites. These remedial alternatives are as follows:

- Alternative 1 – No Action
- Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls
- Alternative 3 – Removal, Treatment, and Disposal
- Alternative 4 – Capping
- Alternative 5 – Partial Removal, Treatment, and Disposal with Capping
- Alternative 6 – In Situ Vitrification.

7.1 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternative 1 would, with one exception, fail to provide overall protection of human health and the environment because contaminants at concentrations above the preliminary remediation goals (PRG) would remain on site with no actions to restrict intrusion or protect groundwater. The 216-B-64 Retention Basin is a candidate for the no-action alternative because the site never was used. None of the other waste sites in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU likely would be remediated under the no-action alternative.

Alternative 2 would not provide overall protection of human health and the environment for a majority of the waste sites in these OUs. If no credit is taken for existing soil covers, all of the representative waste sites in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 OUs exceed criteria for human health direct-contact exposure, inadvertent intruder exposure, and/or ecological exposure. If credit is taken for the current cover, representative sites meet human health direct-contact exposure criteria, but the 216-Z-11 Ditch and 216-T-26 Crib still exceed the criteria for an inadvertent intruder. The 216-U-10 Pond, 216-U-14 Ditch, and the 216-T-26 Crib exceed groundwater protection criteria.

Alternative 3 is considered protective of long-term human health and the environment; however, because contaminants are removed below PRGs, considerable resources would be expended to remove the deep contamination from the area beneath the 216-U-10 Pond and 216-T-26 Crib. These resources include land to stockpile uncontaminated overburden, disposal space at the

Environmental Restoration Disposal Facility (ERDF) landfill, doses to workers, and in some cases, deep excavations would extend into existing structures and operating facilities (e.g., tank farms). Furthermore, Alternative 3 would expose workers to higher levels of radioactive contamination and radiation exposure than is the case with other alternatives. Exceptions are the 216-U-14 Ditch analogous sites and the 216- T-26 Crib analogous sites, where the worker dose is approximately 0.02 rem and 0.6 rem, respectively. Doses at the remaining sites range from 1.4 to more than 5.8 rem, depending on the types and concentrations of contaminants at these waste sites. Alternative 3 potentially would expose workers to higher industrial safety risks during remediation.

Alternative 4 is considered protective of human health and the environment because it would break potential exposure pathways to receptors through placement of a surface barrier and implementation of institutional controls. The barrier also would provide groundwater protection by limiting and controlling infiltration. Barriers would be designed commensurate with site contaminant conditions and institutional controls would be used at capped sites to augment protectiveness. The sites would incorporate monitoring and inspections of barrier performance. The cap would provide additional intrusion protection past the 150-year active institutional control period and infiltration control to protect groundwater.

Alternative 4 is protective, provided monitoring (e.g., monitored natural attenuation, barrier performance, groundwater protection) is implemented where groundwater protection criteria are exceeded. Alternatives 2, 4, 5, and 6 would leave contaminants on site and would require institutional controls to be protective over the necessary timeframe, although Alternative 6 may require some level of institutional controls to control radiation exposures.

Alternative 5 is considered protective of human health and the environment because it would break potential exposure pathways to receptors through placement of a barrier to limit infiltration. The barrier would provide additional distance between potential human and ecological receptors. Partial removal of the more shallow contamination would reduce human health and ecological risk for those sites where contamination is in the 0 to 4.6 m (0- to 15-ft) below ground surface zone (except the 216-T-26 Crib where contaminants are removed to 30 ft) and intruder risk associated with high concentrations at the bottom of the waste site. While, in the long term, this alternative is protective of human health and the environment, the radiological risk to workers during the excavation essentially is the same as for Alternative 3 because the material being removed under Alternative 5 is the same material that causes most of the dose for the full-excavation alternative.

Institutional controls, including maintenance of the cap, land-use restrictions, and monitoring, would be instituted at capped sites until the remedial action objectives are achieved through natural attenuation. The cap would be designed to maximally limit infiltration. Alternative 6, applicable for the Z-Ditches only, is considered protective of human health and the environment for sites selected because it immobilizes the contaminants, preventing further migration. A cap, similar to the cap used in Alternative 5, may be required to augment protectiveness until PRGs are achieved through natural attenuation. The cap would provide additional intrusion protection past the 150-year active institutional control period and infiltration control to protect groundwater.

7.2 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Alternative 1 complies with applicable or relevant and appropriate requirements (ARAR) for the 216-B-64 Retention Basin (200-SC-1 OU) and meets the criteria for the no action alternative, as this site did not receive waste. For all other waste sites discussed in this feasibility study, Alternative 1 does not comply with ARARs.

Alternative 2 generally does not comply with ARARs because it is not protective of human health and the environment for all of the representative sites. However, this alternative may comply with all ARARs for the 207-A North Retention Basin, a site with low levels of contamination inside the basin and no evidence of contamination spread to areas outside the basins.

Alternative 3 complies with ARARs because it removes contamination to the PRGs. Worker protection ARARs may be exceeded, however, without adequate worker protections, due to the high concentrations of contaminants associated with some waste sites.

Alternative 4 complies with ARARs by breaking exposure pathways. Where contaminants remain at depths that exceed the groundwater protection criterion, vadose zone or groundwater monitoring will be required to show protectiveness of groundwater.

Alternative 5 complies with most ARARs by breaking exposure pathways, through removal of shallow contaminants followed by a cap to protect the groundwater from deeper contaminants. This alternative removes contaminants in the shallow zone or near surface followed by filling the site to grade with clean soil and placing a soil barrier over the site. Where contaminants remain at depths that exceed the groundwater protection criterion, vadose zone and/or groundwater monitoring will be required to verify protectiveness of groundwater. Worker protection ARARs may be exceeded, however, without adequate worker protections, due to the high concentrations of contaminants associated with some waste sites.

Alternative 6 complies with ARARs by reducing the mobility of contaminants. Contaminants are immobilized, mitigating migration of treated waste through the vadose zone. If radiation doses in the 0 to 4.6 m (0- to 15-ft) zone are above PRGs, a cap similar in construction to the cap discussed for Alternative 5 may be required to meet ARARs. Groundwater protection standards are not exceeded at the Z-Ditches. Worker protection ARARs may be exceeded; however, without adequate worker protections, due to the high concentrations of contaminants associated with some waste sites.

7.3 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternative 1 is not effective in the long term for all waste sites, except one evaluated in this feasibility study, because waste remains in place without any protections. Because it did not receive radioactive waste, the 216-B-64 Retention Basin would have long-term effectiveness and permanence under Alternative 1.

Alternative 2 would not be an effective and permanent remedial action in the long term for most of the waste sites in these OUs because of the extended period of time that the contaminants would remain on site. Alternative 2 is effective for the 207-A North Retention Basin because low levels of fixed contamination are present in the basin but no contamination has been found from leakage outside the basin.

Alternative 3 would provide a high degree of effectiveness in the long term. With Alternative 3, contaminant concentrations above the PRGs would be removed. The removed contaminated material would be disposed of at the ERDF or at the Waste Isolation Pilot Plant, if some of the waste were determined to contain TRU[1] constituents at levels of concern (e.g., the Z-Ditches).

Alternative 4 also provides a high degree of overall effectiveness in the long term for a majority of the sites, because it addresses all the potential pathways: direct exposure by humans and biota and protection of groundwater. Several studies at the Hanford Site have shown that contaminant transport through the vadose zone is linked to the rate that water moves through the vadose zone or the recharge rate. PNNL-14744, *Recharge Data Package for the 2005 Integrated Disposal Facility Performance Assessment*, indicates recharge rates can vary from nearly zero, in silt loam soil covered in sagebrush to more than 100 mm/yr (3.94 in/yr) in gravel-covered soil without vegetation. As shown in Appendix A, the majority of the sites currently are gravel covered to sparsely covered with vegetation. As such, the current recharge rate is expected to be closer to 100 mm/yr (3.94 in/yr).

The study presents a range of recharge rates possible for the Modified RCRA Subtitle C Barrier. The range is 0.2 mm/yr (0.0079 in/yr) as the upper bound to 0.008 mm/yr (0.0003 in/yr) as the lower bound. A best case (best case is defined as what is reasonably expected to occur) recharge rate of 0.01 mm/yr (0.0004 in/yr) is recommended for a Modified RCRA Subtitle C Barrier. The Hanford barrier is a more robust barrier that provides additional features, additional intrusion barriers, and additional drainage layers to protect human health and the environment. As such, it is at least as protective as the Modified RCRA Subtitle C Barrier and can be expected to perform similarly with regard to recharge rate.

Alternative 4 would be protective by breaking the exposure pathways and reducing the infiltration through the vadose zone. Long-term effectiveness depends on the design and maintenance of the cap and associated monitoring (e.g., cap performance, natural attenuation). For those waste sites where deeper contamination is identified as exceeding groundwater protection criteria, Alternative 4 would require additional monitoring (e.g., groundwater protection); therefore, long-term restrictions would apply.

Alternative 5 would be protective in the long term by removing substantial amounts of contamination and by using soil barriers to break exposure pathways and reduce infiltration through contaminants remaining in the vadose zone. Long-term effectiveness depends on the design and maintenance of the barrier and associated monitoring (e.g., barrier performance, natural attenuation). For those waste sites where deeper contamination is identified as exceeding

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[1]Waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years.

groundwater protection criteria, Alternative 5 would require additional monitoring (e.g., groundwater protection); therefore, long-term restrictions would apply.

Alternative 6 is protective for the selected sites because it binds the contamination into a glass matrix with very low leach rates. To be effective in the long-term, a barrier may be required if surface dose is a problem after implementation of the alternative. Groundwater protection standards are not exceeded at the Z-Ditches. Long-term effectiveness depends on the design and maintenance of the cap (if required) and associated monitoring (e.g., cap performance, natural attenuation). If a barrier were required, additional monitoring would be required; therefore, long-term restrictions would apply.

7.4 REDUCTION IN TOXICITY, MOBILITY, OR VOLUME THROUGH TREATMENT

With exception of Alternative 6 (Z-Ditches only), where treatment is performed, none of the alternatives include treatment and, therefore, do not reduce toxicity, mobility, or volume of the contaminants through treatment. Alternative 6 reduces toxicity and mobility by immobilizing contaminants and binding them into a glass-like matrix that minimizes leaching. The volume of contaminated soil could be reduced by approximately 20 to 50 percent. All the alternatives incorporate natural attenuation in the form of radiological decay, which ultimately results in reduced toxicity and volume.

7.5 SHORT-TERM EFFECTIVENESS

Alternative 1 would be effective in the short term because it does not involve any remedial actions; however, at some sites with contaminants in the active rooting zone or burrowing animal zone, biota could be exposed to unacceptable concentrations. Alternatives 2, 4, and 6 would be more effective in the short term than Alternatives 3 and 5, predominantly because of lower risk to remediation workers.

Alternative 3 would generate large volumes of contaminated soil and debris, which would create a potential for short-term worker impacts during excavation and transportation of the excavated materials. In addition, contaminant concentrations are high enough at these waste sites to potentially result in significant doses to workers during the excavation of soils.

Risks to workers from potential exposure to contaminated soil and fugitive dust would be greater in the short term with Alternatives 3 and 5 than with Alternatives 4 or 6; however, for some of the sites, Alternative 4 also would entail aboveground structure demolition, transportation of contaminated debris, and filling of subsurface void spaces. Short-term impacts to vegetation and wildlife will be significant for Alternatives 3 and 5 because of disturbances at the waste site associated with soil removal, construction, and disturbances at the borrow sites for backfill and/or cap materials. The actual short-term impacts to vegetation and wildlife will vary from site to site but are considered significant because of the large disturbed area. Alternatives 3, 4, and 5 have the highest probability of affecting cultural resources in the short term because of the large land area disturbance; however, the waste sites are located in historically disturbed areas.

Alternative 4 would pose less risk to workers than Alternatives 3 and 5, because the "remove and dispose" component of the capping alternative is limited to aboveground structures and would affect only a few of the waste sites. Limited waste would be handled, so the risks to remediation workers associated with this option would be lower than those related to the large-scale excavation, characterization, transportation, and disposal of waste with the remove and dispose alternative. Additional short-term risk to workers would be expected from the transportation of materials and construction of the caps, but these activities would pose less short-term risk than activities associated with the remove and dispose alternatives. Furthermore, because of the smaller land area affected and the shorter duration to implement the capping alternative, Alternative 4 would be more effective than Alternatives 3 and 5 in the short term with respect to reduced impact on potential cultural and ecological resources.

Alternative 5 would present approximately the same risks to workers as Alternative 3 because of the high dose received during the removal operation. The construction risk to workers would be less than Alternative 3, mainly because of time to implement. Capping activities present the same level of risk as Alternative 4 but the overall cumulative risk for Alternative 5 would be greater than Alternative 4. Disposal of all the contaminated soils at the onsite disposal facility (ERDF) would require approximately 2.6 million yd^3 of space. The current available volume at ERDF is approximately 7.3 million yd^3.

Alternative 6 presents approximately the same short-term risk to workers as Alternative 4. Alternative 4 involves the movement and placement of large quantities of cap materials by heavy equipment, which poses an industrial hazard to workers, whereas Alternative 6 involves minimal hazards from movement of heavy equipment, with the exception of movement of offgas hoods, electrical cables, trailers, and placement of electrodes using lifting equipment. Alternative 6 does have short-term worker risk from electrical hazards associated with vitrification, which are controlled by safety barriers and operational and safety procedures. Limited waste would be handled; therefore, the risks to remediation workers associated with this option would be lower than those related to the large-scale excavation, characterization, transportation, and disposal of waste with the remove and dispose alternative. Additional short-term risk to workers would be expected if cap construction is required, but these activities would pose less short-term risk than activities associated with the remove and dispose alternative. Furthermore, because of the smaller land area affected and the shorter duration required to implement this alternative, Alternative 6 would be more effective than Alternatives 3, 4, and 5 in the short term with respect to reduced impact on potential cultural and ecological resources.

7.6 IMPLEMENTABILITY

Alternative 1 would be easily implemented because no action is performed.

Alternative 2 is currently in use for all of the waste sites. The waste sites are in a surveillance and monitoring program and are posted with signs and/or the area is fenced. Access to the waste sites also is controlled through Hanford Site access requirements, an excavation permit program, and a radiation work permit program. The addition of monitoring wells or boreholes is easily implementable.

Alternative 3 would be the most difficult to implement for most sites, because of the difficulties and safety requirements associated with the excavation, transportation, and disposal of soil and debris. This remedy is not considered implementable at the following sites:

- 216-T-4A Ditch because of the excavation extending into the T Tank Farm
- 216-A-6 Crib and grouped unplanned release (UPR) sites (UPR-200-E-19, -21, and -29) because of the excavation extending into the AP Tank Farm
- 216-A-30 and A-37-2 Cribs because of the excavation extending into the Waste Vitrification Plant construction area
- 216-S-25 Crib because of the excavation extending into the SX Tank Farm.

Alternative 3 would involve excavation and segregation of pipes, concrete structures, and other solid waste. Disposal of all the contaminated soils at the ERDF would require approximately 41 million yd^3 of space, which far exceeds the available volume at ERDF, which is approximately 7.3 million yd^3 (December 2003).

Alternative 4 is implementable. A barrier has been implemented at the Hanford Site; other types of barriers have been approved and implemented at other western arid sites and are easy to construct and maintain. Facilities and infrastructure near waste sites could influence the implementability of a surface barrier option at a particular site. In addition, larger ponds, long ditches, and long process sewers (e.g., 216-U-10 Pond [30-acre site], 216-U-14 Ditch [5,680 ft long], and 200-W-88 Process Sewer [10,330 ft long]) also could influence the implementability of surface barriers due to potential difficulties in obtaining sufficient barrier material, especially silt.

Alternative 5 is a combination of Alternatives 3 and 4 and would be implementable. This alternative would excavate the waste sites to depths reachable with standard earth-moving equipment. Some of the equipment, notably the excavation equipment, would require modification to protect workers and work in the high dose areas. The cap would be designed and constructed to limit infiltration, an activity that readily is implementable. Worker risk is the biggest hindrance to implementability of this alternative.

Alternative 6 is in an earlier stage of development, but potentially is implementable to vitrify the Z-Ditches. In situ vitrification has been demonstrated at similar sized sites. Melts performed side by side have been demonstrated to fuse together thereby indicating that waste between melts are processed; however, Alternative 6 does involve a technology that is at an earlier phase of development than any of the other alternatives. Questions regarding potential implementation of this technology include the following:

- Effective depth
- Assurance of acceptable glass form at the bottom of the melt
- Proper mixing of the soil
- Performance of glass for 1,000 years
- Glass formula evaluation and addition of new material
- In-process sampling analysis accuracy

- Homogeneity of glass formed
- Exposure and radiation levels at the top of the melt.

As discussed in Chapter 4.0, this technology has been demonstrated at other sites for some applications but not at the Hanford Site since the early 1990s. A detailed engineering assessment should be performed to ensure implementability and performance acceptance. This technology potentially could present a cost-effective alternative for specific waste site conditions at the Hanford Site.

7.7 COST

The cost to implement the alternatives is presented in Chapter 6.0, Chapter 8.0, and Appendix D. The following comparisons are generic in nature only to compare the relative costs of the alternatives. If specific cost comparisons are required, consult Chapter 6.0, Tables 8-1 through 8-5, or Appendix D.

Alternative 1 has no cost associated with it and has no additional benefit to human health and the environment over current risks. Alternative 2 generally does not protect human health and the environment; however, Alternative 2 would have the lowest cost because it is minimally invasive and does not include labor-intensive activities. Alternative 3 is the most costly because of the depth of excavation and high contamination levels that will require specialized excavation and waste-handling processes. Alternative 4 generally is less expensive than Alternatives 3 and 5. Alternative 4 tends to be the most cost effective because this alternative addresses all the exposure pathways while minimizing worker risk associated with the high contaminant concentrations and the spread of contaminants deep in the vadose zone. Alternatives 3 and 5 meet the overall protectiveness goal but at significantly more cost, in dollars and dose to workers. Alternative 5 reduces intruder risk and generally is more expensive than Alternative 4 but less expensive than Alternative 3. Alternative 6 is about as cost effective as Alternative 4.

7.8 REFERENCES

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.

PNNL-14744, 2004, *Recharge Data Package for the 2005 Integrated Disposal Facility Performance Assessment*, Pacific Northwest National Laboratory, Richland, Washington.

CHAPTER 8.0 TERMS

ARAR	applicable or relevant and appropriate requirement
FS	feasibility study
IC	institutional control
ISV	in situ vitrification
MESC	maintain existing soil cover
MNA	monitored natural attenuation
N/A	not applicable
OU	operable unit
PRG	preliminary remediation goal
ROD	record of decision
RTD	removal, treatment, and disposal
TMV	toxicity, mobility, or volume through treatment

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8.0 CONCLUSIONS AND PATH FORWARD

This chapter summarizes the results of the feasibility study (FS) and presents the path forward for the 200-CW-5 operable unit (OU), 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites. This chapter identifies the preferred alternatives for remediation of the waste sites.

8.1 FEASIBILITY STUDY SUMMARY

Six remedial alternatives were evaluated for the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites. These alternatives included the following:

- Alternative 1 – No Action
- Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls
- Alternative 3 – Removal, Treatment, and Disposal
- Alternative 4 – Capping
- Alternative 5 – Partial Removal, Treatment, and Disposal with Capping
- Alternative 6 – In Situ Vitrification (Z-Ditches only).

The alternatives were evaluated against the *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) criteria, and then they were evaluated against each other using the CERCLA criteria. Tables 8-1 through 8-5 show the preferred remediation alternative for each representative site and associated analogous waste sites in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU. These tables also provide summary justification for the preferred alternative selection based on the detailed and comparative analyses presented in Chapters 6.0 and 7.0 of this FS.

Only 13 waste sites (including one representative site, the 216-U-10 Pond) out of 48 waste sites within these four OUs have inventory data (contaminants and volumes). Additionally, the configuration of the representative sites, as compared to many analogous sites, may be significantly different (e.g., ponds to ditches, concrete structures, and cribs). This makes comparisons between representative sites and some analogous sites difficult for the selection of the preferred remediation alternative. For these reasons, if analogous sites have an option between two alternatives that comply with the CERCLA threshold and balancing criteria, the lower cost option is selected.

8.1.1 Representative Site 216-U-10 Pond and its Analogous Waste Sites

The 216-U-10 Pond, located administratively within the 200-CW-5 OU, is the representative site for the following waste sites:

- 216-S-16P Pond
- 216-S-17 Pond
- 216-T-4A Pond
- 216-T-4B Pond
- 216-U-9 Ditch
- 216-U-11 Ditch
- 216-S-5 Crib
- 216-S-6 Crib
- 216-A-6 Crib
- 216-A-30 Crib
- 216-S-25 Crib
- 216-A-37-2 Crib
- 216-B-55 Crib
- 216-S-172 Control Structure
- 2904-S-160 Control Structure
- 2904-S-170 Control Structure
- 2904-S-171 Control Structure
- 207-S Retention Basin
- 216-B-64 Retention Basin
- 200-E-113 Process Sewer
- UPR-200-E-19
- UPR-200-E-21
- UPR-200-E-29
- UPR-200-W-124.

Currently, the 216-U-10 Pond exceeds direct contact human health and ecological preliminary remediation goals (PRG) if no credit is taken for the existing soil cover, and exceeds groundwater protection PRGs. The preferred alternative for this representative site is Alternative 4 – Capping, because this alternative is protective of human health, groundwater, the environment, and workers; is easily implementable; and is cost-effective.

Except for seven analogous waste sites discussed below, the preferred alternative for the remaining 216-U-10 Pond analogous waste sites, as shown in Table 8-1, is Alternative 4 – Capping. This alternative is protective of human health, groundwater, and the environment and is implementable with minimal worker risk for these waste sites.

The preferred alternative for the analogous waste sites 216-S-172 Control Structure, 2904-S-160 Control Structure, 2904-S-170 Control Structure, 2904-S-171 Control Structure, 207-S Retention Basin, and 200E-113 process sewer is Alternative 3 – Removal, Treatment, and Disposal. This alternative is protective of human health, groundwater, and the environment because it removes the source of contamination, is implementable with acceptable worker risk, and is the lowest cost alternative.

The preferred alternative for the analogous waste site 216-B-64 Retention Basin is Alternative 1 – No Action. This retention basin, although pre-operationally tested with noncontaminated liquid, never was used. Because this site did not receive waste, this alternative is more protective of human health and the environment and is implementable with no worker risk.

Table 8-1 provides a summary of the analysis of alternatives supporting the selection of the preferred alternatives for this group of waste sites.

8.1.2 Representative Site 216-U-14 Ditch and its Analogous Waste Sites

The 216-U-14 Ditch, located administratively within the 200-CW-5 OU, is the representative site for the following waste sites:

- 216-S-16D Ditch
- 216-T-1 Ditch
- 216-T-4-1D Ditch
- 216-T-4-2 Ditch
- 216-W-LWC Crib
- 207-U Retention Basin
- 207-T Retention Basin
- 216-T-12 Trench
- 200-W-84 Process Sewer
- 200-W-88 Process Sewer
- 200-W-102 Process Sewer
- UPR-200-W-111
- UPR-200-W-112.

Currently, the 216-U-14 Ditch exceeds direct contact human health PRGs if no credit is taken for the existing soil cover and exceeds groundwater protection PRGs. The preferred alternative for this representative site and its analogous waste sites is Alternative 3 – Removal, Treatment, and Disposal. This alternative is more protective of human health and the environment because it removes the source of contamination, is cost-effective, and is implementable with acceptable worker risk.

Table 8-2 provides a summary of the analysis of alternatives supporting the selection of the preferred alternatives for this group of waste sites.

8.1.3 Representative Site 216-Z-11 Ditch and its Analogous Waste Sites

The 216-Z-11 Ditch, located administratively within the 200-CW-5 OU, is the representative site for the following waste sites:

- 216-Z-1D Ditch
- 216-Z-19 Ditch
- 216-Z-20 Crib
- 207-Z Retention Basin
- UPR-200-W-110.

Currently, the 216-Z-11 Ditch exceeds direct contact and intruder human health PRGs if no credit is taken for the existing soil cover. Groundwater protection is not required. The preferred alternative for this representative site and its analogous sites (except the 207-Z Retention Basin) is Alternative 4 – Capping, because this alternative is protective of groundwater, the workers, and the environment; is easily implementable; and is cost-effective. Alternative 6 could be the recommended alternative; however, a detailed engineering assessment should be conducted to determine whether Alternative 6 – In Situ Vitrification, is a viable, cost-effective option for treatment of these waste sites, given the high concentration of transuranic radionuclides present and the relatively shallow location of the majority of contaminants. Results of such an assessment may support selection of a different preferred alternative.

The preferred alternative for the 207-Z Retention Basin is Alternative 3 – Removal, Treatment, and Disposal. This alternative is protective of human health and the environment because it removes the source of contamination, is cost-effective, and is implementable with acceptable worker risk.

Table 8-3 provides a summary of the analysis of alternatives supporting the selection of the preferred alternatives for this group of waste sites.

8.1.4 Representative Site 216-A-25 Pond and its Analogous Waste Site

The 216-A-25 Pond, located administratively within the 200-CW-1 OU, is the representative site for the 207-A North Retention Basin.

Based on current conditions, the 216-A-25 Pond exceeds direct contact human health and ecological PRGs if no credit is taken for the existing soil cover. Groundwater protection is not required. The preferred alternative for this representative site is Alternative 4 – Capping. The logic for selection of this alternative is discussed in DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*.

The preferred alternative for the 207-A North Retention Basin is Alternative 3 – Removal, Treatment, and Disposal. The basin is described as a series of three Hypalon-lined concrete basins. No leakage outside the basin assembly has been documented and the basins are not controlled radiologically. This alternative is protective of human health and the environment, is cost-effective, and is implementable with minimal worker risk.

Table 8-4 provides a summary of the analysis of alternatives supporting the selection of the preferred alternatives for this group of waste sites.

8.1.5 Representative Site 216-T-26 Crib and its Analogous Waste Sites

The 216-T-26 Crib, located administratively within the 200-TW-1 OU, is the representative site for the following waste sites:

- 216-T-36 Crib
- 200-W-79 Pipeline.

Currently, the 216-T-26 Crib exceeds intruder human health and ecological PRGs and exceeds groundwater PRGs. The preferred alternative for this representative site is Alternative 4 – Capping. The logic for selection of this alternative is discussed in DOE/RL- 2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit)*.

The preferred alternative for analogous site 216-T-36 Crib, is Alternative 4 – Capping. This alternative is more protective of human health and the environment, is cost-effective, and is implementable with minimal worker risk for this waste site. The preferred alternative for analogous site 200-W-79 Pipeline is Alternative 3 - Removal, Treatment, and Disposal. This alternative is protective of human health, groundwater, and the environment because it removes the source of contamination, is cost-effective, and is implementable with minimal worker risk for this waste site.

Table 8-5 provides a summary of the analysis of alternatives supporting the selection of the preferred alternatives for this group of waste sites.

8.2 PATH FORWARD

A proposed plan is being prepared to document the preferred alternatives for the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites (DOE/RL 2004-26, *Proposed Plan for the 200-CW-5 (U Pond/Z Ditches), 200-CW-2 (S Pond/Ditches), 200-CW-4 (T Pond/ Ditches) Cooling Water Groups, and 200-SC-1 Steam Condensate Group Operable Units*). The proposed plan details the closure options, and it documents that the waste sites will be remediated in accordance with the record of decision (ROD), developed following issuance of the proposed plan.

The representative sites in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU were evaluated in this FS, based on data generated through a limited field investigation. The analogous sites for the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites were evaluated based on data generated for the representative sites, or on site-specific data.

DOE/RL-98-28, *200 Areas Remedial Investigation/Feasibility Study Implementation Plan – Environmental Restoration Program*, defines this strategy as a means to streamline remedial investigations and focus the CERCLA process to obtain a decision. As identified in DOE/RL-98-28, additional sampling phases conducted post-ROD are meant to augment the remedial investigation data, confirm the alternative selection, support the design, and provide information for final site closeout. Confirmatory sampling is conducted to confirm that the representative site distribution model used to evaluate the analogous site is appropriate to the site conditions and to confirm that the appropriate remedial alternative was selected. Design sampling is conducted to obtain data necessary to design the remedial alternative and refine the cost estimated for the FS. Verification sampling is conducted to verify that the remedial goals have been met by the implementation of the remedial alternative. Table 8-6 presents the confirmatory, design, and verification sampling phases and presents assumed data needs for each sampling phase for the representative sites and for analogous sites that are similar (or equal) to the representative sites, are less contaminated (or have lower risk) than the representative sites, or are more contaminated (or have higher risk) than the representative sites (see Chapter 2.0 for additional details). This table builds off the decision logic presented in Figure 2-14 (Application of the Analogous Site Approach) and Table 2-2 (Analogous Site Table) and provides a basis for initiating the data quality objectives process for the confirmatory sampling and design sampling phases.

Post-ROD sampling will be determined through data quality objectives identification and a sampling and analysis plan that will be developed to direct the sampling needed at the analogous sites. This sampling will be used to confirm that the correct alternative has been selected and to provide design data through a "plug-in" approach, as defined in the following sections.

Some of the analogous sites likely will undergo a remove and dispose alternative; these sites will use the observational approach during removal. Sites slated for caps will need additional data to confirm the lateral extent and to support cap design. Sites slated for no action may need verification sampling, depending on the amount, type, and quality of data available to support the no-action decision. CERCLA operations and maintenance sampling could include the monitoring of natural attenuation and performance monitoring of the cap.

Because the Z-Ditches contain high concentrations of transuranic radionuclides, Alternative 6 – In Situ Vitrification, may be a more viable, cost-effective option. A detailed engineering assessment should be conducted to ensure implementability and performance acceptance for treatment of these waste sites because of the high concentrations of transuranic radionuclides present and the relatively shallow location of the majority of contaminants (to 5.3 m [17.5 ft]).

8.2.1 Plug-in Approach of the 200-CW-5 Operable Unit, 200-CW-2 Operable Unit, 200 CW-4 Operable Unit, and 200-SC-1 Operable Unit Waste Sites

The plug-in approach is a process that helps make remedial action decisions for additional waste sites using existing CERCLA evaluations. In the future, the plug-in approach is proposed for any similar waste sites already defined within the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU and for newly discovered waste sites that have a similar conceptual site model to waste sites already addressed in this FS. The plug-in approach will be used on the analogous sites considered in this FS after additional data are collected in the confirmatory and design sampling phases.

The plug-in approach benefits the goal of remediating waste sites within the OUs in conjunction with the analogous site approach. The traditional CERCLA approach for remedy selection would require the development of multiple proposed plans and RODs that, for similar sites, would be nearly identical to the FSs, proposed plans, and RODs already developed and proven to be successful. The plug-in approach allows remedial actions to begin much more quickly at a waste site, without the need for redundant remedy selection processes.

The plug-in approach requires three main elements to establish its use as a cost-effective tool for remediation.

- First, multiple sites must be identified that share common physical and contaminant characteristics. These characteristics are referred to as the conceptual site model.
- Second, a remedial alternative, or standard remedy, must be established that has been shown to be protective and cost-effective for sites that share the common conceptual site model.
- Finally, sites sharing a common conceptual site model must be shown to require remedial action due to contaminant concentrations that pose risk to human health and the environment.

To use the plug-in approach for a waste site not evaluated in the Feasibility Study, the site must fit the defined conceptual model and must be shown to require remedial action. The site can then be "plugged in" to the standard remedy. The following information describes how the plug-in approach is proposed for remedy selection.

8.2.1.1 Establishing the Conceptual Site Model

Four conceptual site models have been defined based on the site characteristics contained in the FS. These characteristics include the following:

- Type of contaminant inventory
- Concentrations of contaminants in environmental media
- Types of contaminated environmental media (soil) or material (e.g., concrete, metal, wood)
- Extent of contamination within the environment (i.e., the depth of discharge, the expected contaminant distributions, and the potential for hydrologic and contaminant impacts to groundwater).

Based on the representative sites evaluated in the FS, the following four conceptual site models were developed:

- Waste sites where no hazardous material was disposed at the waste site or where contaminants disposed of currently meet the RAOs.
- Waste sites where limited contamination exists at the waste sites, an existing soil cover is in place and of sufficient thickness to provide protection, contaminants are expected to meet the RAOs during the institutional control period (such as within 150 years), and groundwater PRGs are not exceeded. Contaminated environmental media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes.
- Waste sites where contaminants exceed the RAOs and contamination is shallow, low-volume, and can be cost effectively remedied through removal, treatment, and disposal. Typically, these contaminants exceed the human health and ecological PRGs; however, groundwater PRGs are not exceeded at depths that make excavation impracticable. Contaminated environmental media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and vent pipes.
- Waste sites where contaminants exceed the PRGs, where contaminants are at concentrations that pose a significant worker risk, and where the contaminants having potential to adversely affect groundwater are at significant depth. Contaminated environmental media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes.
- Waste sites where contaminants exceed the PRGs, where contaminants are at concentrations that would not pose a significant worker risk, and where the contaminants having potential to adversely affect groundwater are at significant depth. Contaminated environmental media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes.

8.2.1.2 Establishment of the Standard Remedy

The standard remedies, based on the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites, have been defined on the basis of the conceptual models presented by the representative waste sites, as well as the alternative evaluations conducted for all waste sites. As such, six standard remedies are identified for potential plug-in sites. These remedies are highlighted below along with their required characteristics.

- **Alternative 1: No Action** has been defined as a standard remedy for waste sites whose conceptual site model indicates that no hazardous materials were disposed at the waste site or that contaminants disposed of currently meet the RAOs.
- **Alternative 2: Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls** has been defined as the standard remedy for waste sites whose conceptual site model indicates that limited contamination exists at the waste sites, an existing soil cover is in place and of sufficient thickness to provide protection,

contaminants are expected to meet the RAOs during the institutional control period (such as within 150 years), and groundwater PRGs are not exceeded. Contaminated environmental media is similar to the media at the waste sites included in this FS. This media includes soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes.

- **Alternative 3: Removal, Treatment, and Disposal** has been defined as the standard remedy for waste sites whose conceptual site model indicates that contaminants exceed the RAOs and that contamination is shallow, low-volume, and can be cost effectively remedied through the removal, treatment, and disposal of contaminated media. Typically, as shown in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU waste sites, these contaminants exceed the human health and ecological PRGs. Contaminated environmental media is similar to the media at the waste sites included in this FS. This media includes soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes.

- **Alternative 4: Capping** has been defined as the standard remedy for waste sites whose conceptual site model indicates that contaminants exceed the RAOs and that the contaminants at greater depths have a potential to adversely impact groundwater. Contaminant concentrations and contaminated environmental media are similar to the media at the waste sites included in this FS. These media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes. Contaminant concentrations would indicate potential to adversely affect groundwater and would pose significant worker protection and intruder risk. Contaminants may also pose a risk to humans and ecological receptors, depending on the depth to the top of the contamination.

- **Alternative 5: Partial Removal, Treatment, and Disposal with Capping** has been defined as the standard remedy for waste sites where contaminants exceed the PRGs, where removal of contaminants in the near-surface zone would not pose a significant worker risk but would result in substantial risk reduction, and where the contaminants having potential to adversely impact groundwater are at significant depth. The contaminants that can be readily excavated would be removed and remaining contaminants would be capped to provide groundwater protection. Contaminant concentrations and contaminated environmental media generally are similar to the media at the waste sites included in this FS; however, the concentrations are high enough to result in real risk reduction in the near surface without exposing workers to unacceptable risks. Contaminated environmental media include soil, solid waste, debris, and materials associated with the waste sites, such as timbers and pipes. Cost analysis would be required to ensure that this alternative is cost-effective when compared to either Alternative 3 or Alternative 4.

- **Alternative 6: In Situ Vitrification** has been defined as a potential remedy where significant concentrations of transuranic radionuclides are present, the waste is relatively shallow, contaminant concentrations may pose significant worker risk, and may pose significant intruder risk. Contaminants also may pose a direct contact risk to humans and ecological receptors, depending on the depth to the top of the contamination. Cost analysis would be required to ensure vitrification is cost-effective when compared to waste handling, packaging, transport, and disposal of the waste at the required waste disposal facility (e.g., Waste Isolation Pilot Plant for the Z-Ditches). Costs of vitrification should include an analysis as to whether a cap is required. A cap may be required if contamination below the vitrified zone exceeds groundwater protection PRGs or if radiation dose rates may exceed applicable PRGs.

8.2.1.3 Establishing the Need for Remedial Action

Waste sites that share a common conceptual site model will "plug-in" to the standard remedy if they are determined to require remedial action due to a risk to human health and the environment (based on the defined RAOs and associated PRGs, as defined previously). Some of the waste sites in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU likely will require confirmatory sampling to validate the conceptual site model and the identified preferred remedy. The preferred remedy will be implemented following confirmation of the conceptual site model. Should the confirmatory sampling indicate variations in the defined conceptual site model, this plug-in approach will be used to define the appropriate remedy.

8.3 PUBLIC INVOLVEMENT IN THE PLUG-IN APPROACH

To ensure that the public is involved in the application of the plug-in approach, the U.S. Department of Energy, U.S. Environmental Protection Agency, and Washington State Department of Ecology will publish explanations of significant differences at the following points in the plug-in process:

- When newly discovered waste sites are proven through analysis to be above remediation goals and can plug in to the standard remedy

- When confirmatory sampling identified for the waste sites discussed herein indicates variations in the defined conceptual site model such that the preferred remedy is no longer protective.

8.4 REFERENCES

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Table 8-2. Preferred Alternative for the Representative Site 216-U-14 Ditch and its Analogous Waste Sites.[e] (5 Pages)

Comparison of Alternatives - Representative Site 216-U-14 Ditch and Associated Analogous Sites					
Criteria for Representative and Analogous Waste Sites	Alternatives				
	① No Action	② MESC, MNA, IC[a]	③ RTD[b]	④ Capping	⑤ RTD/ Capping[d]

[a]Maintain existing soil cover, monitored natural attenuation, and institutional controls.
[b]Removal, treatment, and disposal.
[c]Toxicity, mobility, or volume through treatment.
[d]Partial removal, treatment, and disposal with capping – not applicable for 216-U-14 Ditch or its analogous waste sites.
[e]The choice of the preferred alternative is based on information at the writing of this feasibility study. The preferred alternative may be revised based on future characterization efforts at the analogous sites.

☑ = Indicates the preferred alternative (e).
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
IC = institutional controls.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.
TMV = toxicity, mobility, or volume through treatment.

Table 8-3. Preferred Alternative for the Representative Site 216-Z-11 Ditch and its Analogous Waste Sites.[f] (2 Pages)

Comparison of Alternatives - Representative Site 216-Z-11 Ditch and Associated Analogous Sites						
Criteria for Representative and Analogous Waste Sites	Alternatives					
	① No Action	② MESC, MNA, IC[a]	③ RTD[b]	④ Capping	⑤ RTD/ Capping[d]	⑥ ISV[e]

[a]Maintain existing soil cover, monitored natural attenuation, and institutional controls.
[b]Removal, treatment, and disposal.
[c]Toxicity, mobility, or volume through treatment.
[d]Partial removal, treatment, and disposal with capping – not applicable for 216-Z-11 Ditch or its analogous sites.
[e]In situ vitrification.
[f]The choice of the preferred alternative is based on information at the writing of this feasibility study. The preferred alternative may be revised based on future characterization efforts at the analogous sites.
[g]This cost does not reflect the programmatic disposal cost at the Waste Isolation Pilot Plant. If the programmatic disposal cost were included, the total cost for this alternative would be $142,247,000.

☑ = Indicates the preferred alternative (f).
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
IC = institutional controls.
ISV = in situ vitrification.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
N/A = not applicable.
RTD = removal, treatment, and disposal.
TMV = toxicity, mobility, or volume through treatment.

Table 8-5. Preferred Alternative for the Representative Site 216-T-26 Crib Analogous Waste Sites.[e] (2 Pages)

Comparison of Alternatives - Representative Site 216-T-26 Crib Analogous Sites					
	Alternatives				
Criteria for Representative and Analogous Waste Sites	① No Action	② MESC, MNA, IC[a]	③ RTD[b]	④ Capping	⑤ RTD/ Capping[d]

[a]Maintain existing soil cover, monitored natural attenuation, and institutional controls.
[b]Removal, treatment, and disposal.
[c]Toxicity, mobility, or volume through treatment.
[d]Partial removal, treatment, and disposal with capping.
[e]The choice of the preferred alternative is based on information at the writing of this feasibility study. The preferred alternative may be revised based on future characterization efforts at the analogous sites.

☑ = Indicates the preferred alternative (e).
☑ = Yes, meets criterion.
☐ = No, does not meet criterion.
◆ = High: best satisfies evaluation guidelines.
◈ = Moderate: partially satisfies evaluation guidelines.
◇ = Low: least satisfies evaluation guidelines.

ARAR = applicable or relevant and appropriate requirement.
IC = institutional controls.
MESC = maintain existing soil cover.
MNA = monitored natural attenuation.
RTD = removal, treatment, and disposal.
TMV = toxicity, mobility, or volume through treatment.

Table 8-6. Post-Record of Decision Sampling. (2 Pages)

Alternative	Confirmatory Sampling						Design Sampling	Verification Sampling		
	Confirm Appropriate Remedial Action	Nature of Contamination	Extent of Contamination	Groundwater Protection	Ecological Sampling	Observational Approach	Extent of Contamination	Verify No-Action Alternative	Ecological Sampling	Verify PRG Attainment
Alternative 1 – No Action								•	•	•
Alternative 2 – Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls										
Representative Site			•		•				•	
Analogous Site Equal to Representative Site			•							
Analogous Site Less than Representative Site			•	•						
Analogous Site Greater than Representative Site	•	•	•	•	•				•	
Alternative 3 – Removal, Treatment, and Disposal										
Representative Site						•			•	•
Analogous Site Equal to Representative Site						•				•
Analogous Site Less than Representative Site	•					•				•
Analogous Site Greater than Representative Site						•			•	•
Alternative 4 – Capping										
Representative Site					•				•	
Analogous Site Equal to Representative Site										
Analogous Site Less than Representative Site	•									
Analogous Site Greater than Representative Site					•					
Alternative 5 – Partial Removal, Treatment, and Disposal with Capping										
Representative Site					•		•			•
Analogous Site Equal to Representative Site					•		•			•
Analogous Site Less than Representative Site	•						•			•
Analogous Site Greater than Representative Site				•		•			•	•

Table 8-6. Post-Record of Decision Sampling. (2 Pages)

Alternative	Confirmatory Sampling						Design Sampling	Verification Sampling		
	Confirm Appropriate Remedial Action	Nature of Contamination	Extent of Contamination	Groundwater Protection	Ecological Sampling	Observational Approach	Extent of Contamination	Verify No-Action Alternative	Ecological Sampling	Verify PRG Attainment
Alternative 6 – In Situ Vitrification										
Representative Site	•	•	•	•	•		•			•
Analogous Site Equal to Representative Site	•						•			•
Analogous Site Less than Representative Site	•						•			•
Analogous Site Greater than Representative Site	•	•	•	•	•		•			•

PRG = preliminary remediation goal.
● = If an issue at the representative site.

9.0 REFERENCES

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APPENDIX A

WASTE SITE PHOTOS

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APPENDIX A

WASTE SITE PHOTOS

200-CW-5 Operable Unit, 200-CW-2 Operable Unit, 200-CW-4 Operable Unit, and 200-SC-1 Operable Unit Waste Site Photos

This appendix provides a photographic summary of the waste sites addressed in this feasibility study. The photos represent current conditions. This appendix is organized numerically by the waste site designation. Where appropriate, photographs are included that show waste sites that are in proximity to each other. Table A-1 summarizes the waste site, structure type, and waste site group.

Table A-1. 200-CW-5 Operable Unit, 200-CW-2 Operable Unit, 200-CW-4 Operable Unit, and 200-SC-1 Operable Unit Waste Sites. (2 Pages)

Waste Site	Structure Type	Group
216-U-9	Pond	Cooling Water
216-U-10	Ditch	Cooling Water
216-U-11	Ditch	Cooling Water
216-U-14	Ditch	Cooling Water
207-U	Retention Basin	Cooling Water
216-W-LWC	Crib	Cooling Water
200-W-84	Process Sewer	Cooling Water
216-Z	Ditches	Cooling Water
216-S-17	Pond	Cooling Water
216-S-16P	Pond	Cooling Water
207-S	Retention Basin	Cooling Water
216-S-172	Control Structure	Cooling Water
216-S-160	Control Structure	Cooling Water
200-E-113	Process Sewer	Steam Condensate
216-A-37-2	Control Structure	Steam Condensate
216-T-36	Retention Basin	Steam Condensate
200-W-79	Pipeline	Steam Condensate
207-Z	Retention Basin	Steam Condensate
207-A North	Retention Basin	Steam Condensate

Waste Site	Structure Type	Group
216-S-16-D	Ditch	Cooling Water
216-T-4A and B	Ponds	Cooling Water
216-T-1	Ditch	Cooling Water
216-T-4-1D	Ditch	Cooling Water
216-T-4-2	Ditch	Cooling Water
207-T	Retention Basin	Cooling Water
200-W-88	Process Sewer	Cooling Water
216-T-12	Trench	Cooling Water
216-S-5	Crib	Steam Condensate
216-S-6	Crib	Steam Condensate
216-A-6	Crib	Steam Condensate
216-A-30	Crib	Steam Condensate
216-S-25	Crib	Steam Condensate
216-B-55	Crib	Steam Condensate
216-B-64	Crib	Steam Condensate

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APPENDIX B

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

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CONTENTS

TABLES

TERMS

ARAR	applicable or relevant and appropriate requirement
CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
CFR	*Code of Federal Regulations*
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
HEPA	high-efficiency particulate air
MCL	maximum contaminant level
OU	operable unit
PCB	polychlorinated biphenyl
RCRA	*Resource Conservation and Recovery Act of 1976*
TBC	to be considered
WAC	*Washington Administrative Code*

APPENDIX B

POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

B1.0 P OTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

This appendix identifies and evaluates potential applicable or relevant and appropriate requirements (ARAR) for waste site remediation in the 200-CW-5 Operable Units (OU), 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU. The potential ARARs identified in this document have been used to form the basis for the levels to which contaminates must be remediated to protect human health and the environment. The *Comprehensive Environmental Response, Compensation, and Liability Act of 1980* (CERCLA) provides for the identification of to-be-considered (TBC) nonpromulgated advisories, criteria, guidance, or proposed standards that may be consulted to interpret ARAR to-be-determined remediation goals when ARARs do not exist or are insufficient. Independent of the TBC and ARARs identification process at the Hanford Site, the requirements of U.S. Department of Energy (DOE) orders must be met.

Because the waste sites in the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU will be remediated under a CERCLA decision document, remedial and corrective actions at the sites will be required to meet ARARs. This appendix identifies and evaluates potential ARARs for these sites. Final ARARs for remediation will be established in the record of decision. In many cases, the ARARs form the basis for the preliminary remediation goals to which contaminants must be remediated to protect human health and the environment. In other cases, the ARARs define or restrict how specific remedial measures can be implemented.

The ARARs identification process is based on CERCLA guidance (EPA/540/G-89/006, *CERCLA Compliance with Other Laws Manual: Interim Final* and EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*). Section 121 of CERCLA, as amended, requires, in part, that any applicable or relevant and appropriate standard, requirement, criterion, or limitation promulgated under any Federal environmental law, or any more stringent state requirement promulgated pursuant to a state environmental statute, be met (or a waiver justified) for any hazardous substance, pollutant, or contaminant that will remain onsite after completion of remedial action.

Under this process, potential ARARs are classified into one of three categories: chemical-specific, location-specific, or action-specific. These categories are defined as follows.

- Chemical-specific requirements are usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of public and worker safety levels and site cleanup levels.

- Location-specific requirements are restrictions placed on the concentration of dangerous substances or the conduct of activities solely because they occur in special geographic areas.

- Action-specific requirements are usually technology- or activity-based requirements or limitations triggered by the remedial actions performed at the site.

When requirements in each of these categories are identified, a determination must be made as to whether those requirements are ARARs. A requirement is applicable if the specific terms or jurisdictional prerequisites of the law or regulations directly address the circumstances at a site. If not applicable, a requirement may nevertheless be relevant and appropriate if (1) circumstances at the site are, based on best professional judgment, sufficiently similar to the problems or situations regulated by the requirement and (2) the requirement's use is well suited to the site. Only the substantive requirements (e.g., use of control/containment equipment, compliance with numerical standards) associated with ARARs apply to CERCLA onsite activities. ARARs associated with administrative requirements, such as permitting, are not applicable to CERCLA onsite activities (CERCLA, Section 121[e][1]). In general, this CERCLA permitting exemption will be extended to all remedial and corrective action activities conducted at the 200-CW-5 OU, 200-CW-2 OU, 200-CW-4 OU, and 200-SC-1 OU, with the exception of the *Resource Conservation and Recovery Act of 1976* (RCRA) units, which will be incorporated into WA7890008967, *Hanford Facility RCRA Permit*.

TBC information is nonpromulgated advisories or guidance issued by Federal or state governments that is not legally binding and does not have the status of potential ARARs. In some circumstances, TBCs will be considered along with ARARs in determining the remedial action necessary for protection of human health and the environment. The TBCs complement the ARARs in determining protectiveness at a site or implementation of certain actions. For example, because soil cleanup standards do not exist for all contaminants, health advisories, which would be TBCs, may be helpful in defining appropriate remedial action goals.

B1.1 WAIVERS FROM APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

The U.S. Environmental Protection Agency (EPA) may waive ARARs and select a remedial action that does not attain the same level of site cleanup as that identified by the ARARs. Section 121 of the *Superfund Amendments and Reauthorization Act of 1986* identifies six circumstances in which the EPA may waive ARARs for onsite remedial actions. The six circumstances are as follows:

- The remedial action selected is only a part of a total remedial action (such as an interim action), and the final remedy will attain the ARAR upon its completion

- Compliance with the ARAR will result in a greater risk to human health and the environment than alternative options

- Compliance with the ARAR is technically impracticable from an engineering perspective

- An alternative remedial action will attain an equivalent standard of performance through the use of another method or approach

- The ARAR is a state requirement that the state has not consistently applied (or demonstrated the intent to apply consistently) in similar circumstances
- In the case of Section 104 (Superfund-financed remedial actions), compliance with the ARAR will not provide a balance between protecting human health and the environment and the availability of Superfund money for response at other facilities.

B1.2 POTENTIAL ARARS APPLICABLE TO REMEDIAL ACTIONS FOR WASTE SITES IN THE 200-CW-5, 200-CW-2, 200-CW-4, AND 200-SC-1 OPERABLE UNITS

Potential Federal and state ARARs are presented in Tables B-1 and B-2, respectively. The chemical-specific ARARs likely to be most relevant to remediation of the 200-CW-5, 200-CW-2, 200-CW-4 and 200-SC-1 OUs are elements of the Washington State regulations that implement WAC 173-340, "Model Toxics Control Act -- Cleanup," specifically associated with developing risk-based concentrations for cleanup (WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties"). The requirements of WAC 173-340-745 risk-based concentrations help establish soil cleanup standards for nonradioactive and radioactive contaminants at waste sites. The several Federal and state air emission standards are likely to be important in identifying air emission limits and control requirements for any remedial actions that produce air emissions. RCRA land-disposal restrictions will be important standards during the management of wastes generated during remedial actions.

No location-specific ARARs have been identified for the waste sites considered in this focused feasibility study.

Action-specific ARARs that could be pertinent to remediation are state solid and dangerous waste regulations (for management of characterization and remediation wastes and performance standards for waste left in place), *Atomic Energy Act of 1954* regulations (for performance standards for radioactive waste sites), and Federal and state regulations related to air emissions.

B2.0 R EFERENCES

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40 CFR 141, "National Primary Drinking Water Regulations," Title 40, *Code of Federal Regulations*, Part 141, as amended.

40 CFR 761, "Polychorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," Title 40, *Code of Federal Regulations*, Part 761, as amended.

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WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides," *Washington Administrative Code*, as amended, Washington State Department of Ecology, Olympia, Washington.

Table B-1. Identification of Potential Federal Applicable or Relevant and Appropriate Requirements and to be Considered for the Remedial Action Sites. (2 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"National Primary Drinking Water Regulations," 40 CFR 141			
"Maximum Contaminant Levels for Organic Contaminants," 40 CFR 141.61	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of organic contaminants in drinking water.	The groundwater in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units is not currently used for drinking water. However, 200 Area groundwater is hydraulically connected to the Columbia River (which is used for drinking water). Remedial alternatives must ensure migration of contaminants from the waste sites do not cause degradation at the point of compliance; therefore, the substantive requirements in 40 CFR 141.61 for organic constituents are relevant and appropriate.
"Maximum Contaminant Levels for Inorganic Contaminants," 40 CFR 141.62	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of inorganic contaminants in drinking water.	The groundwater in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units is not currently used for drinking water. However, 200 Area groundwater is hydraulically connected to the Columbia River (which is used for drinking water). Remedial alternatives must ensure migration of contaminants from the waste sites do not cause degradation at the point of compliance; therefore, the substantive requirements in 40 CFR 141.62 for inorganic constituents are relevant and appropriate.
"Maximum Contaminant Levels for Radionuclides," 40 CFR 141.66	ARAR	Establishes MCLs that are drinking water criteria designed to protect human health from the potential adverse effects of radionuclides in drinking water.	The groundwater in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units is not currently used for drinking water. However, 200 Area groundwater is hydraulically connected to the Columbia River (which is used for drinking water). Remedial alternatives must ensure migration of contaminants from the waste sites do not cause degradation at the point of compliance; therefore, the substantive requirements in 40 CFR 141.66 for radionuclides are relevant and appropriate.
"Polychorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions," 40 CFR 761			
"Applicability," Specific Subsections: 40 CFR 761.50(b)(1) 40 CFR 761.50(b)(2) 40 CFR 761.50(b)(3) 40 CFR 761.50(b)(4) 40 CFR 761.50(b)(7) 40 CFR 761.50(c)	ARAR	These regulations establish standards for the storage and disposal of PCB wastes.	The substantive requirements of these regulations are potentially applicable or relevant and appropriate to the storage and disposal of PCB liquids, items, remediation waste, and bulk product waste at ≥50 ppm. The specific subsections identified from 40 CFR 761.50(b) reference the specific sections for the management of PCB waste type. The disposal requirements for radioactive PCB waste are addressed in 40 CFR 761.50(b)(7).

Table B-1. Identification of Potential Federal Applicable or Relevant and Appropriate Requirements and to be Considered for the Remedial Action Sites. (2 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"National Emission Standards for Hazardous Air Pollutants," 40 CFR 61			
"Standard," 40 CFR 61.92	ARAR	Requires that emissions of radionuclides to the ambient air from U.S. Department of Energy facilities shall not exceed amounts that would cause any member of the public to receive in any year an effective dose equivalent of 10 mrem/yr.	The substantive requirements of this standard are potentially applicable to remedial action activities in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units, such as excavation of contaminated soils and the operation of air quality management equipment in support of remediation activities, which may result in the release radioactive particulates to unrestricted areas. As a result, requirements limiting emissions potentially apply. This is a risk-based standard for protecting human health and the environment.
"Emission Monitoring and Test Procedures," 40 CFR 61.93	ARAR	Establishes the methods for monitoring emissions rates from existing point sources.	The substantive requirements of this standard are potentially applicable because emissions of radionuclides to the ambient air may result from remediation activities performed in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units, or from related use of temporary sources such as air quality management equipment in support of remediation activities.
Regulations pursuant to the *Resource Conservation and Recovery Act of 1976* and implemented through WAC 173-303, "Dangerous Waste Regulations" (see Table B-2).			

40 CFR 141, "National Primary Drinking Water Regulations."

40 CFR 761, "Polychorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions."

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

ARAR = applicable or relevant and appropriate requirement.
CFR = *Code of Federal Regulations.*
HEPA = high-efficiency particulate air.
MCL = maximum contaminant level.
PCB = polychlorinated biphenyl.
TBC = to be considered.
WAC = *Washington Administrative Code.*

Table B-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Sites. (5 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Dangerous Waste Regulations," WAC 173-303			
"Identifying Solid Waste," WAC 173-303-016	ARAR	Identifies those materials that are and are not solid wastes.	Substantive requirements of these regulations are potentially applicable because these define how to determine which materials are subject to the designation regulations. Specifically, materials that are generated for removal from the CERCLA site during the remedial action would be subject to the procedures for identification of solid waste to ensure proper management.
"Recycling Processes Involving Solid Waste," WAC 173-303-017	ARAR	Identifies materials that are and are not solid wastes when recycled.	Substantive requirements of these regulations are potentially applicable because these define how to determine which materials are subject to the designation regulations. Specifically, materials that are generated for removal from the CERCLA site during the remedial action would be subject to the procedures for identification of solid waste to ensure proper management.
"Designation of Dangerous Waste," WAC 173-303-070	ARAR	Establishes the method for determining whether a solid waste is, or is not, a dangerous waste or an extremely hazardous waste.	Substantive requirements of these regulations are potentially applicable to materials encountered during the remedial action. Specifically, solid waste that is generated for removal from the CERCLA site during this remedial action would be subject to the dangerous waste designation procedures to ensure proper management.
"Excluded Categories of Waste," WAC 173-303-071	ARAR	Describes those categories of wastes that are excluded from the requirements of WAC 173-303 (excluding WAC 173-303-050).	The conditions of this requirement are applicable to remedial actions in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units should wastes identified in WAC 173-303-071 be encountered.
"Conditional Exclusion of Special Wastes," WAC 173-303-073	ARAR	Establishes the conditional exclusion and the management requirements of special wastes, as defined in WAC 173-303-040.	Substantive requirements of these regulations are potentially applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of special waste are applicable to the interim management of certain waste that will be generated during the remedial action.

Table B-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Sites. (5 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Requirements for Universal Waste," WAC 173-303-077	ARAR	Identifies those wastes exempted from regulation under WAC 173-303-140 and WAC 173-303-170 through 173-303-9907 (excluding WAC 173-303-960). These wastes are subject to regulation under WAC 173-303-573.	Substantive requirements of these regulations are potentially applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of universal waste are applicable to the interim management of certain waste that will be generated during the remedial action.
"Recycled, Reclaimed, and Recovered Wastes," WAC 173-303-120 Specific Subsections: WAC 173-303-120(3) WAC 173-303-120(5)	ARAR	These regulations define the requirements for the recycling of materials that are solid and dangerous waste. Specifically, WAC 173-303-120(3) provides for the management of certain recyclable materials, including spent refrigerants, antifreeze, and lead-acid batteries. WAC 173-303-120(5) provides for the recycling of used oil.	Substantive requirements of these regulations are potentially applicable to certain materials that might be encountered during the remedial action. Recyclable materials that are exempt from regulation as dangerous waste and that are not otherwise subject to CERCLA as hazardous substances can be recycled and/or conditionally excluded from certain dangerous waste requirements.
"Land Disposal Restrictions," WAC 173-303-140(4)	ARAR	This regulation establishes state standards for land disposal of dangerous waste and incorporates by reference, Federal land disposal restrictions of 40 CFR 268 that are applicable to solid waste that designates as dangerous or mixed waste in accordance with WAC 173-303-070(3).	The substantive requirements of this regulation are potentially applicable to materials encountered during the remedial action. Specifically, dangerous/mixed waste that is generated and removed from the CERCLA site during the remedial action for offsite (as defined by CERCLA) land disposal would be subject to the identification of applicable land disposal restrictions at the point of generation of the waste. The actual offsite treatment of such waste would not be ARAR to this remedial action, but would instead be subject to all applicable laws and regulations.
"Requirements for Generators of Dangerous Waste," WAC 173-303-170	ARAR	Establishes the requirements for dangerous waste generators.	Substantive requirements of these regulations are potentially applicable to materials encountered during the remedial action. Specifically, the substantive standards for management of dangerous/mixed waste are applicable to the interim management of certain waste that will be generated during the remedial action. For purposes of this remedial action, WAC 173-303-170(3) includes the substantive provisions of WAC 173-303-200 by reference. WAC 173-303-200 further includes certain substantive standards from WAC 173-303-630 and -640 by reference.

Table B-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Sites. (5 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Model Toxics Control Act – Cleanup," WAC 173-340			
"Soil Cleanup Standards for Industrial Properties," WAC 173-340-745(5)(b)	ARAR	Identifies the methods used to identify risk-based concentrations and their use in the selection of a cleanup action. Cleanup and remediation levels are based on protection of human health and the environment, the location of the site, and other regulations that apply to the site. The standard specifies cleanup goals that implement the strictest Federal or state cleanup criteria.	The state-established risk-based concentrations for soils and protection of groundwater are potentially relevant and appropriate to the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units waste site remedial actions, because no Federal standard exists.
"Minimum Functional Standards for Solid Waste Handling," WAC 173-304			
"On-Site Containerized Storage, Collection and Transportation Standards for Solid Waste," WAC 173-304-200(2)	ARAR	Establishes the requirements for the on-site storage of solid wastes that are not radioactive or dangerous wastes.	Substantive requirements of these regulations are potentially applicable to materials encountered during the remedial action. Specifically, nondangerous, nonradioactive solid wastes (i.e., hazardous substances that are only regulated as solid waste) that will be containerized for removal from the CERCLA site would be managed onsite according to the substantive requirements of this standard.
"Solid Waste Handling Standards," WAC 173-350			
"On-Site Storage, Collection and Transportation Standards," WAC 173-350-300	ARAR	Establishes the requirements for the temporary storage of solid waste in a container on site and the collecting and transporting of the solid waste.	The substantive requirements of this newly promulgated rule are potentially relevant and appropriate to the on-site collection and temporary storage of solid wastes at the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units remediation waste sites. Compliance with this regulation is being implemented in phases for existing facilities.

Table B-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Sites. (5 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
"Minimum Standards for Construction and Maintenance of Wells," WAC 173-160			
WAC 173-160-161	ARAR	Identifies well planning and construction requirements.	The substantive requirements of this regulation are potentially applicable to actions that include construction of wells used for groundwater extraction, monitoring, or injection of treated groundwater or wastes. The requirements of WAC 173-160-161 through 173-160-381 (excluding 173-160-211, 173-160-251, 173-160-261, 173-160-361, 173-160-400, 173-160-420, 173-160-430, 173-160-440, 173-160-450, and 173-160-460) are applicable to groundwater well construction, monitoring, or injection of treated groundwater or wastes in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units.
WAC 173-160-171	ARAR	Identifies the requirements for locating a well.	
WAC 173-160-181	ARAR	Identifies the requirements for preserving natural barriers to groundwater movement between aquifers.	
WAC 173-160-191	ARAR	Identifies the design and construction requirements for completing wells.	
WAC 173-160-201	ARAR	Identifies the casing and liner requirements for water supply wells.	
WAC 173-160-221	ARAR	Identifies the requirements for sealing materials.	
WAC 173-160-231	ARAR	Identifies the requirements for surface seals on water wells.	
WAC 173-160-241	ARAR	Identifies the requirements for formation sealing.	
WAC 173-160-271	ARAR	Identifies the special sealing standards for driven wells, jetted wells, and dewatering wells.	
WAC 173-160-281	ARAR	Identifies the construction standards for artificial gravel-packed wells.	
WAC 173-160-291	ARAR	Identifies the standards for the upper terminal of water wells.	
WAC 173-160-301	ARAR	Identifies the requirements for temporary capping.	
WAC 173-160-311	ARAR	Identifies the requirements for well tagging.	
WAC 173-160-321	ARAR	Identifies the standards for testing a well.	
WAC 173-160-331	ARAR	Identifies the method for keeping equipment and the water well free of contaminants.	
WAC 173-160-341	ARAR	Identifies the method for ensuring the quality of the well water.	
WAC 173-160-351	ARAR	Identifies the standards for the installation of a pump.	
WAC 173-160-371	ARAR	Identifies the standard for chemical conditioning.	

Table B-2. Identification of Potential State Applicable and Relevant or Appropriate Requirements and to be Considered for the Remedial Action Sites. (5 Pages)

ARAR Citation	ARAR or TBC	Requirement	Rationale for Use
WAC 173-160-381	ARAR	Identifies the standard for decommissioning a well.	
WAC 173-160-400	ARAR	Identifies the minimum standards for resource protection wells and geotechnical soil borings.	
WAC 173-160-420	ARAR	Identifies the general construction requirements for resource protection wells.	
WAC 173-160-430	ARAR	Identifies the minimum casing standards.	
WAC 173-160-440	ARAR	Identifies the equipment cleaning standards.	
WAC 173-160-450	ARAR	Identifies the well sealing requirements.	
WAC 173-160-460	ARAR	Identifies the decommissioning process for resource protection wells.	
"General Regulations for Air Pollution Sources," WAC 173-400			
"General Standards for Maximum Emissions," WAC 173-400-040	ARAR	Establishes the general emission standards for emission units. Emission standards identified in other chapters for specific emission units will take precedence over the general emission standards of this section.	The substantive requirements of this standard are potentially relevant and appropriate to remedial actions performed at the site that could result in the emission of criteria pollutants (i.e. fugitive dust). Substantive standards established for the control and prevention of air pollution under this regulation are considered to be relevant and appropriate to remedial actions that may be proposed at a site.
"Ambient Air Quality Standards and Emission Limits for Radionuclides," WAC 173-480			
"Emission Monitoring and Compliance Procedures," WAC 173-480-070	TBC	Requires that radionuclide emissions shall be determined by calculating the dose to members of the public at the point of maximum annual air concentration in an unrestricted area where any member of the public may be.	The substantive requirements of this standard are applicable to remedial actions conducted in the 200-CW-5, 200-CW-2, 200-CW-4, and 200-SC-1 Operable Units, as excavation of contaminated soil may emit radionuclides to unrestricted areas.

Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 USC 9601, et seq.
WAC 173-160, "Minimum Standards for Construction and Maintenance of Wells."
WAC 173-303, "Dangerous Waste Regulations."
WAC 173-340, "Model Toxics Control Act – Cleanup."
WAC 173-350, "Solid Waste Handling Standards."
WAC 173-400, "General Regulations for Air Pollution Sources."
WAC 173-480, "Ambient Air Quality Standards and Emission Limits for Radionuclides."

ARAR = applicable or relevant and appropriate requirement.
CERCLA = *Comprehensive Environmental Response, Compensation, and Liability Act of 1980.*
CFR = *Code of Federal Regulations.*
TBC = to be considered.
WAC = *Washington Administrative Code.*

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APPENDIX C

TABLES FOR THE BASELINE HUMAN HEALTH, SCREENING LEVEL ECOLOGICAL, AND GROUNDWATER PROTECTION RISK ASSESSMENTS

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TABLES

APPENDIX C

TABLES FOR THE BASELINE HUMAN HEALTH, SCREENING LEVEL ECOLOGICAL, AND GROUNDWATER PROTECTION RISK ASSESSMENTS

This appendix contains tables that support the discussion in Section 2.7 of the feasibility study, which summarizes the detailed risk assessment presentation in the remedial investigation. The tables in this appendix are a key subset of those in DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report*; DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit*; and DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units*. In a few cases, most notably the RESidual RADioactivity (RESRAD) analyses, this appendix uses updated information not used in the remedial investigation reports.

Table C-1. Summary of Contaminants of Potential Concern Identified at each Representative Waste Site. (3 Pages)

Constituent Name	216-Z-11 Ditch[a]		216-U-10 Pond[a]		216-U-14 Ditch[a]		216-T-26 Crib[b]		216-A-25 Pond[c]	
	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone
nitrate (as N)			•[d]	•[d]						
nitrite (as N)	•	•								
antimony			•	•	•	•				•
barium			•	•						
boron	•	•								
cadmium			•	•						
chromium		•	•	•						
cobalt				•						
copper	•	•	•	•						
cyanide			•	•						
hexavalent chromium	•	•								
lead			•	•						
manganese			•	•						
mercury	•	•	•	•						
molybdenum	•	•								
nickel			•	•		•				
selenium			•							•
silver			•	•	•	•				
thallium			•	•		•			•	•
uranium			•	•					•	
zinc			•	•					•	
Aroclor-1254	•	•	•	•		•				
Aroclor-1260	•	•	•	•						
DDD			•	•						

Table C-1. Summary of Contaminants of Potential Concern Identified at each Representative Waste Site. (3 Pages)

Constituent Name	216-Z-11 Ditch[a]		216-U-10 Pond[a]		216-U-14 Ditch[a]		216-T-26 Crib[b]		216-A-25 Pond[c]	
	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone	Shallow Zone	Deep Zone
americium-241	•	•	•	•	•	•		•	•	•
antimony-125					•	•				
cesium-137	•	•	•	•	•	•		•	•	•
cobalt-60			•	•	•	•			•	•
europium-152			•	•						
europium-154			•	•				•	•	
europium-155			•	•				•	•	
neptunium-237		•	•	•						
plutonium-238	•	•	•	•				•		
plutonium-238/239					•	•				
plutonium-239/240	•	•	•	•	•	•		•	•	
potassium-40					•	•				
radium-226	•	•	•	•		•				•
radium-228									•	•
selenium-79			•	•						
sodium-22			•	•						
strontium-90	•	•	•	•	•	•		•	•	•
technetium-99			•	•	•	•				•
thorium-228										•
thorium-230	•	•								•
thorium-232			•	•						•
uranium-233/234			•	•				•		
uranium-234			•	•						
uranium-235			•	•	•	•				

Table C-1. Summary of Contaminants of Potential Concern Identified at each Representative Waste Site. (3 Pages)

Constituent Name	**216-Z-11 Ditch**[a]		**216-U-10 Pond**[a]		**216-U-14 Ditch**[a]		**216-T-26 Crib**[b]		**216-A-25 Pond**[c]	
	Shallow Zone	**Deep Zone**	**Shallow Zone**	**Deep Zone**	**Shallow Zone**	**Deep Zone**	**Shallow Zone**	**Deep Zone**	**Shallow Zone**	**Deep Zone**
uranium-238			•	•	•	•		•		
1,1,1-trichloroethane			•	•						
2-butanone (MEK)			•	•		•				
acetone	•	•	•	•	•	•				
bis(2-ethylhexyl) phthalate	•	•	•	•		•				
carbon disulfide			•	•						
chloroform			•	•						
diethyl phthalate			•							
di-n-butyl phthalate			•							
methylene chloride	•	•			•	•				
phenol										
toluene			•	•						

[a] Information from DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] Information from DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit).*

[c] Information from DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.*

[d] Reported as total nitrogen for nitrate and nitrite.

Table C-2. Comparison of True Mean Shallow Soil Concentrations from the 216-Z-11 Ditch to Soil Risk-Based Concentrations.[a]

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	Industrial Soil RBC[b]	Does Average Concentration Exceed Industrial Soil RBC?
CONV	nitrite	mg/kg	2	2	100%	38	350,000	no
METAL	boron	mg/kg	4	4	100%	6.7	315,000	no
METAL	copper	mg/kg	4	4	100%	20	129,500	no
METAL	hexavalent chromium	mg/kg	3	1	33%	0.33	10,500	no
METAL	mercury	mg/kg	4	2	50%	0.19	1,050	no
METAL	molybdenum	mg/kg	4	3	75%	1.7	17,500	no
PEST/PCB	Aroclor-1254	mg/kg	4	1	25%	13	70	no
PEST/PCB	Aroclor-1260	mg/kg	4	1	25%	19	66	no
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	3	1	33%	0.13	9,375	no
VOC	acetone	mg/kg	3	3	100%	0.0080	3.15×10^{6}	no
VOC	methylene chloride	mg/kg	3	2	67%	0.0053	17,500	no

[a] Constituent statistics and analytical results from Table 5-23 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] WAC 173-340-745 calculations or CLARC Version 3.1, Table, Method C.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

CONV = conventional parameter.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table C-3. Comparison of True Mean Shallow Soil Concentrations from the 216-U-10 Pond to Soil Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	Industrial Soil RBC[b]	Does Average Concentration Exceed Industrial Soil RBC?
CONV	nitrate (as N)	mg/kg	19	13	68%	21	350,000	no
METAL	antimony	mg/kg	19	1	5%	5.0	1,400	no
METAL	barium	mg/kg	19	19	100%	106	245,000	no
METAL	cadmium	mg/kg	19	3	16%	1.1	3,500	no
METAL	chromium	mg/kg	19	19	100%	14	10,500	no
METAL	copper	mg/kg	19	17	89%	24	129,500	no
METAL	cyanide	mg/kg	19	1	5%	0.57	70,000	no
METAL	lead	mg/kg	19	19	100%	15	750	no
METAL	manganese	mg/kg	19	19	100%	398	490,000	no
METAL	mercury	mg/kg	19	3	16%	0.14	1,050	no
METAL	nickel	mg/kg	19	19	100%	18	70,000	no
METAL	selenium	mg/kg	19	1	5%	0.30	17,500	no
METAL	silver	mg/kg	19	15	79%	2.5	17,500	no
METAL	thallium	mg/kg	19	4	21%	0.29	280	no
METAL	uranium	mg/kg	19	19	100%	20	10,500	no
METAL	zinc	mg/kg	19	19	100%	91	1.05×10^6	no
Pest/PCB	Aroclor-1254	mg/kg	6	1	17%	0.023	70	no
Pest/PCB	Aroclor-1260	mg/kg	6	2	33%	0.045	66	no
Pest/PCB	DDD	mg/kg	6	1	17%	0.0023	547	no
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	19	2	11%	0.36	9,375	no
SVOC	diethyl phthalate	mg/kg	19	1	5%	0.37	2.80×10^6	no
SVOC	di-n-butyl phthalate	mg/kg	19	1	5%	0.36	350,000	no
VOC	1,1,1-trichloroethane	mg/kg	6	1	17%	0.0052	3.15×10^6	no

Table C-3. Comparison of True Mean Shallow Soil Concentrations from the 216-U-10 Pond to Soil Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	Industrial Soil RBC[b]	Does Average Concentration Exceed Industrial Soil RBC?
VOC	2-butanone (MEK)	mg/kg	6	1	17%	0.012	2.10×10^6	no
VOC	acetone	mg/kg	6	1	17%	0.038	3.15×10^6	no
VOC	carbon disulfide	mg/kg	6	1	17%	0.0057	350,000	no
VOC	chloroform	mg/kg	6	1	17%	0.0048	21,516	no
VOC	toluene	mg/kg	6	2	33%	0.0067	700,000	no

[a]Constituent statistics and analytical results from Table 5-24 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b]WAC 173-340-745 calculations or CLARC Version 3.1, Table, Method C.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

MEK = methyl ethyl ketone.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table C-4. Comparison of True Mean Shallow Soil Concentrations from the 216-U-14 Ditch to Soil Risk-Based Concentrations.[a]

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	Industrial Soil RBC[b]	Does Average Concentration Exceed Industrial Soil RBC?
METAL	antimony	mg/kg	3	3	100%	6.5	1,400	No
METAL	silver	mg/kg	3	3	100%	3.3	17,500	No
VOC	acetone	mg/kg	1	1	100%	0.012	3.15×10^6	No
VOC	methylene chloride	mg/kg	3	3	100%	0.0020	17,500	No

[a] Constituent statistics and analytical results from Table 5-25 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] WAC 173-340-745 calculations or CLARC Version 3.1, Table, Method C.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

CONV = conventional parameter.
RBC = risk-based concentration.
VOC = volatile organic compound.

Table C-5. Comparison of Shallow Soil Concentrations from the 216-A-25 Gable Mountain Pond to Soil Risk-Based Concentrations.[a] (2 Pages)

Contaminant	Units	Number of Samples	Number of Detects	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	95% UCL Conc.	Method C	Does 95% UCL Exceed Method C?	Do More than 10% Exceed Method C?	Does More than 1 Sample Exceed 2X Method C?
acetone	mg/kg	46	29	63	0.002	0.008	4.62×10^{-3}	3.15×10^{6}	No	No	No
antimony	mg/kg	65	21	32	0.21	1	0.23	1400	No	No	No
arsenic	mg/kg	70	70	100	1.5	33.8	5.34	88	No	No	No
barium	mg/kg	70	70	100	31.5	140	80.8	2.45×10^{5}	No	No	No
benzyl butyl phthalate	mg/kg	46	3	7	0.033	0.16	0.16	7.00×10^{5}	No	No	No
bis(2-Ethylhexyl) phthalate	mg/kg	46	1	2	0.059	0.059	0.059	9370	No	No	No
cadmium	mg/kg	70	48	69	0.03	1.7	0.304	3500	No	No	No
chloromethane	mg/kg	46	2	4	0.005	0.006	5.52×10^{-3}	1.01×10^{4}	No	No	No
chromium, total	mg/kg	70	70	100	2.5	24.3	8.99	3.50×10^{6}	No	No	No
copper	mg/kg	70	70	100	11.4	58.8	17.7	1.30×10^{5}	No	No	No
diethyl phthalate	mg/kg	46	6	13	0.05	0.088	0.088	2.80×10^{6}	No	No	No
di-n-butyl phthalate	mg/kg	46	12	26	0.017	1.8	0.466	3.50×10^{5}	No	No	No
fluoride	mg/kg	46	8	17	2	6.9	1.86	2.10×10^{5}	No	No	No
lead	mg/kg	70	70	100	2.1	35.5	6.45	750	No	No	No
2-Butanone (MEK)	mg/kg	46	8	17	0.002	0.002	0.002	2.10×10^{6}	No	No	No
methylene chloride	mg/kg	46	46	100	0.005	0.032	0.0173	1.75×10^{4}	No	No	No
phenol (acid fraction)	mg/kg	46	5	11	0.023	0.033	0.033	1.03×10^{6}	No	No	No
selenium	mg/kg	70	44	63	0.29	1.5	0.589	1.75×10^{4}	No	No	No
thallium	mg/kg	65	51	78	0.43	1.70	0.771	280	No	No	No
toluene	mg/kg	46	1	2	0.001	0.001	0.001	7.00×10^{5}	No	No	No
uranium, total	mg/kg	46	46	100	0.328	2.19	0.814	1.05×10^{4}	No	No	No

Table C-5. Comparison of Shallow Soil Concentrations from the 216-A-25 Gable Mountain Pond to Soil Risk-Based Concentrations.[a] (2 Pages)

Contaminant	Units	Number of Samples	Number of Detects	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	95% UCL Conc.	Method C	Does 95% UCL Exceed Method C?	Do More than 10% Exceed Method C?	Does More than 1 Sample Exceed 2X Method C?
xylenes, total	mg/kg	46	1	2	0.002	0.002	0.002	7.00×10^5	No	No	No
zinc	mg/kg	70	70	100	29.5	204	63.9	1.05×10^6	No	No	No

[a] Constituent statistics and analytical results from Table 4-18 of DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.*
[b] WAC 173-340-745 calculations or CLARC Version 3.1, Table, Industrial Soil Risk Based Concentration, Method C.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

MEK = methyl ethyl ketone.
UCL = upper confidence limit.

Table C-6. Comparison of Maximum Shallow-Zone Soil Concentrations from the 216-Z-11 Ditch to Industrial Ambient Air Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Max Air Concentration (mg/m^3)[b]	Industrial Ambient Air RBC (mg/m^3)[c]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
METAL	boron	mg/kg	4	4	100%	24	1.32×10^{9}	7.58×10^{-10}	1.80×10^{-8}	0.020	No
METAL	copper	mg/kg	4	4	100%	30	1.32×10^{9}	7.58×10^{-10}	2.30×10^{-8}	--	--
METAL	hexavalent chromium	mg/kg	3	1	33%	0.54	1.32×10^{9}	7.58×10^{-10}	4.09×10^{-10}	2.98×10^{-7}	No
METAL	mercury	mg/kg	4	2	50%	0.66	1.32×10^{9}	7.58×10^{-10}	4.98×10^{-10}	--	--
METAL	molybdenum	mg/kg	4	3	75%	0.77	1.32×10^{9}	7.58×10^{-10}	5.83×10^{-10}	--	--
PEST/PCB	Aroclor-1254	mg/kg	4	1	25%	52	1.32×10^{9}	7.58×10^{-10}	3.94×10^{-8}	4.38×10^{-5}	No
PEST/PCB	Aroclor-1260	mg/kg	4	1	25%	78	1.32×10^{9}	7.58×10^{-10}	5.88×10^{-8}	4.38×10^{-5}	No
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	3	1	33%	0.042	1.32×10^{9}	7.58×10^{-10}	3.18×10^{-11}	0.0063	No
VOC	acetone	mg/kg	3	3	100%	0.014	12,554	7.97×10^{-5}	1.12×10^{-6}	0.35	No
VOC	methylene chloride	mg/kg	3	2	67%	0.0080	2,425	4.12×10^{-4}	3.30×10^{-6}	0.053	No
CONV	nitrite	mg/kg	2	2	100%	43	$1.32x10^{9}$	$7.58x10^{-10}$	$3.3x10^{-8}$	--	--

Table C-6. Comparison of Maximum Shallow-Zone Soil Concentrations from the 216-Z-11 Ditch to Industrial Ambient Air Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Max Air Concentration (mg/m^3)[b]	Industrial Ambient Air RBC (mg/m^3)[c]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?

[a] Constituent statistics and analytical results from Table 5-29 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] Maximum detected result divided by PEF or VF, as appropriate.

[c] WAC 173-340-750 and CLARC, Version 3.1, calculations.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-750, "Cleanup Standards to Protect Air Quality."

-- = not available.
PEF = particulate emissions factor.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VF = volatilization factor.
VOC = volatile organic compound.

Table C-7. Comparison of Maximum Shallow-Zone Soil Concentrations from the 216-U-10 Pond to Industrial Ambient Air Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (mg/m^3)[b]	Industrial Ambient Air RBC (mg/m^3)[c]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
METAL	antimony	mg/kg	19	1	5%	12	1.32×10^{9}	7.58×10^{-10}	9.39×10^{-9}	--	No
METAL	barium	mg/kg	19	19	100%	331	1.32×10^{9}	7.58×10^{-10}	2.51×10^{-7}	5.00×10^{-4}	No
METAL	cadmium	mg/kg	19	3	16%	9.1	1.32×10^{9}	7.58×10^{-10}	6.89×10^{-7}	1.39×10^{-5}	No
METAL	chromium	mg/kg	19	19	100%	83	1.32×10^{9}	7.58×10^{-10}	6.27×10^{-8}	2.98×10^{-7}	No
METAL	copper	mg/kg	19	17	89%	163	1.32×10^{9}	7.58×10^{-10}	1.23×10^{-7}	--	No
METAL	cyanide	mg/kg	19	1	5%	0.15	1.32×10^{9}	7.58×10^{-10}	1.14×10^{-10}	0.0030	No
METAL	lead	mg/kg	19	19	100%	107	1.32×10^{9}	7.58×10^{-10}	8.11×10^{-8}	--	No
METAL	manganese	mg/kg	19	19	100%	1,580	1.32×10^{9}	7.58×10^{-10}	1.20×10^{-6}	4.90×10^{-5}	No
METAL	mercury	mg/kg	19	3	16%	1.4	1.32×10^{9}	7.58×10^{-10}	1.06×10^{-9}	--	No
METAL	nickel	mg/kg	19	19	100%	131	1.32×10^{9}	7.58×10^{-10}	9.92×10^{-8}	--	No
METAL	selenium	mg/kg	19	1	5%	1.4	1.32×10^{9}	7.58×10^{-10}	1.06×10^{-9}	--	No
METAL	silver	mg/kg	19	15	79%	24	1.32×10^{9}	7.58×10^{-10}	1.81×10^{-8}	--	No
METAL	thallium	mg/kg	19	4	21%	0.61	1.32×10^{9}	7.58×10^{-10}	4.62×10^{-10}	--	No
METAL	uranium	mg/kg	19	19	100%	270	1.32×10^{9}	7.58×10^{-10}	2.05×10^{-7}	--	No
METAL	zinc	mg/kg	19	19	100%	645	1.32×10^{9}	7.58×10^{-10}	4.89×10^{-7}	--	No
Pest/PCB	Aroclor-1254	mg/kg	6	1	17%	0.041	1.32×10^{9}	7.58×10^{-10}	3.11×10^{-11}	4.38×10^{-5}	No
Pest/PCB	Aroclor-1260	mg/kg	6	2	33%	0.15	1.32×10^{9}	7.58×10^{-10}	1.14×10^{-10}	4.38×10^{-5}	No
Pest/PCB	DDD	mg/kg	6	1	17%	0.0036	1.32×10^{9}	7.58×10^{-10}	2.73×10^{-12}	--	No
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	19	2	11%	0.087	1.32×10^{9}	7.58×10^{-10}	6.59×10^{-11}	0.0063	No
SVOC	diethyl phthalate	mg/kg	19	1	5%	0.067	1.32×10^{9}	7.58×10^{-10}	5.08×10^{-11}	2.8	No
SVOC	di-n-butyl phthalate	mg/kg	19	1	5%	0.053	1.32×10^{9}	7.58×10^{-10}	4.02×10^{-11}	0.35	No

Table C-7. Comparison of Maximum Shallow-Zone Soil Concentrations from the 216-U-10 Pond to Industrial Ambient Air Risk-Based Concentrations.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Maximum Air Concentration (mg/m^3)[b]	Industrial Ambient Air RBC (mg/m^3)[c]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
VOC	1,1,1-trichloroethane	mg/kg	6	1	17%	0.0010	2,391	4.18×10^{-4}	4.18×10^{-7}	11	No
VOC	2-butanone	mg/kg	6	1	17%	0.047	19,422	5.15×10^{-5}	2.42×10^{-6}	1.0	No
VOC	acetone	mg/kg	6	1	17%	0.19	12,554	7.97×10^{-5}	1.51×10^{-5}	0.35	No
VOC	carbon disulfide	mg/kg	6	1	17%	0.0070	1,190	8.40×10^{-4}	5.88×10^{-6}	0.70	No
VOC	chloroform	mg/kg	6	1	17%	0.0020	2,933	3.41×10^{-4}	6.82×10^{-7}	0.0011	No
VOC	toluene	mg/kg	6	2	33%	0.017	3,553	2.81×10^{-4}	4.78×10^{-6}	0.39	No

[a] Constituent statistics and analytical results from Table 5-30 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] Maximum detected result divided by PEF or VF, as appropriate.

[c] WAC 173-340-750 and CLARC, Version 3.1, calculations.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-750, "Cleanup Standards to Protect Air Quality."

--	=	not available.
PEF	=	particulate emissions factor.
PEST/PCB	=	pesticide/polychlorinated biphenyl.
RBC	=	risk-based concentration.
SVOC	=	semivolatile organic compound.
VF	=	volatilization factor.
VOC	=	volatile organic compound.

Table C-8. Comparison of Maximum Shallow-Zone Soil Concentrations from the 216-U-14 Ditch to Industrial Ambient Air Risk-Based Concentrations.[a]

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Maximum Detected Result	PEF or VF (m^3/kg)	1/PEF or 1/VF (kg/m^3)	Max Air Concentration (mg/m^3)[b]	Industrial Ambient Air RBC (mg/m^3)[c]	Does Maximum Air Concentration Exceed Ambient Air Industrial RBC?
METAL	antimony	mg/kg	3	3	100%	6.5	1.32×10^{9}	7.58×10^{-10}	4.92×10^{-9}	--	--
METAL	silver	mg/kg	3	3	100%	3.3	1.32×10^{9}	7.58×10^{-10}	2.50×10^{-9}	--	--
VOC	acetone	mg/kg	1	1	100%	0.012	12,554	7.97×10^{-5}	9.56×10^{-7}	0.35	No
VOC	methylene chloride	mg/kg	3	3	100%	0.0020	2,425	4.12×10^{-4}	8.25×10^{-7}	0.053	No

[a] Constituent statistics and analytical results from Table 5-31 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units*.

[b] Maximum detected result divided by PEF or VF, as appropriate.

[c] WAC 173-340-750 and CLARC, Version 3.1, calculations.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1*.
WAC 173-340-750, "Cleanup Standards to Protect Air Quality."

-- = not available.
PEF = particulate emissions factor.
RBC = risk-based concentration.
VF = volatilization factor.
VOC = volatile organic compound.

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
Exposure pathways	Industrial, Direct Contact Scenario	--	External gamma: active Inhalation: active Plant ingestion: suppressed Meat ingestion: suppressed Milk ingestion: suppressed Aquatic foods: suppressed Drinking water: suppressed Soil ingestion: active Radon: suppressed					Based on 200-CW-5 work plan (DOE/RL-99-66) conceptual exposure model and refinement of the model as part of the RI
	Groundwater Protection Scenario	--	External gamma: suppressed Inhalation: suppressed Plant ingestion: suppressed Meat ingestion: suppressed Milk ingestion: suppressed Aquatic foods: suppressed Drinking water: active Soil ingestion: suppressed Radon: suppressed					

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
R011-CZ	Area of CZ	m^2	121405	4156	972	340000	83	Site-specific areas from WIDS
	Thickness of CZ (Industrial-DC)	m	4.6	4.6	4.6	--	4.6	Assumes that site is contaminated at 95% upper confidence limit from surface to 4.6 m bgs
	Thickness of CZ (no cover GWP)	m	3	6	6	--	--	Represents actual thickness of contamination based on RI results
	Length parallel to aquifer flow	m	500	9	9	250	13	--
	Radiation dose limit (industrial scenario)	mrem/yr	15	15	15	15	15	10 CFR 835
	Elapsed time since waste placement	yr	0	0	0	0	0	Environmental samples were collected in 1999
Exposure point concentration		pCi/g	chemical-specific	chemical-specific	chemical-specific	chemical-specific	chemical-specific	All data are decayed to 2002
R013-cover and CZ hydrological data	Cover depth (no cover, industrial, direct contact and groundwater protection)	m	0	0	0	0	0	No cover
	Cover depth (cover, industrial, direct contact)	m	0.6	2.7	1	--	--	Represents actual conditions of cover based on RI results
	Cover material density (cover, industrial, direct contact)	g/cm^3	1.5	1.8	1.5	1.9	1.5	--
	Cover erosion rate (cover, industrial, direct contact)	m/yr	0.001	0.001	0.001	0.001	0.001	RESRAD default
	Density of CZ	g/cm^3	1.3	1.5	1.8	1.9	2.16	Site-specific values based on RI results
	CZ erosion rate	m/yr	0.001	0.001	0.001	0.001	0.001	RESRAD default
	CZ total porosity	unitless	0.53	0.43	0.33	0.27	0.183	Site-specific values based on physical property samples from RI and WHC-EP-0883

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
	CZ field capacity	unitless	0.2	0.2	0.2	0.2	1.00E-34	Site-specific values based on physical property samples from RI and WHC-EP-0883
	CZ hydraulic conductivity	m/yr	0.06	2.2	22	700	21900	WHC-SD-EN-SE-004
	CZ parameter	unitless	4.05	4.05	4.05	4.05	4.05	RESRAD Table E:2; CCN 070578
	Average annual wind speed	m/sec	3.4	3.4	3.4	--	--	--
	Evapotranspiration coefficient	unitless	0.656	0.656	0.656	0.91	0.91	DOE/RL-2003-11
	Precipitation	m/yr	0.16	0.16	0.16	0.16	0.16	Based on 16 cm (6.3 inches) average annual rainfall (DOE-RL-90-07)
	Irrigation rate (industrial, direct contact)	m/yr	0	0	0	0	0	Assumes no irrigation
	Irrigation rate (groundwater protection)	m/yr	0.76	0.76	0.76	--	--	--
	Irrigation mode	--	Overhead	Overhead	Overhead	Overhead	Overhead	RESRAD default
	Runoff coefficient (groundwater protection)	unitless	0.2	0.2	0.2	0.2	0.2	RESRAD default
	Watershed area for nearby stream or pond (groundwater protection)	m^2	1.00×10^6	1.00×10^6	1.00×10^6	1.00×10^6	1.00×10^6	RESRAD default
	Accuracy for water/soil computations (groundwater protection)	unitless	0.001	0.001	0.001	0.001	0.001	RESRAD default

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
R014 - SZ hydrological data	Density of SZ	g/cm^3	2.23	2.23	2.23	1.9	1.9	Site-specific value based on RI results and BHI-01177
	SZ total porosity	unitless	0.158	0.158	0.158	0.27	0.27	Site-specific values based on physical property samples from RI and WHC-EP-0883
	SZ Effective porosity	unitless	0.158	0.158	0.158	0.23	0.23	Site-specific values based on physical property samples from RI and WHC-EP-0883
	SZ field capacity	unitless	0.04	0.04	0.04	--	1.00E-34	Site-specific values based on physical property samples from RI and WHC-EP-0883
	SZ hydraulic conductivity	m/yr	5519	5519	5519	5500	5520	WHC-SD-EN-SE-004
	SZ parameter	unitless	4.05	4.05	4.05	4.05	4.05	RESRAD Table E:2; CCN 070578
	Water table drop rate	m/yr	0.001	0.001	0.001	0.001	0.001	RESRAD default
	Well pump intake depth below water table	m	4.6	4.6	4.6	4.6	4.6	Typical RCRA well screen length
	ND or mass-balance	--	ND	ND	ND	ND	ND	RESRAD default
	Well pumping rate	m^3/yr	250	250	250	250	250	RESRAD default

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
R015 - Uncon-taminated and unsaturated strata hydrological data	Number of unsaturated strata	--	3	3	3	1	1	Site-specific
	Thickness - Strata 1 (groundwater protection)	m	7	4	4	--	50.6	Site-specific values based on RI results and current water table elevation data
	Thickness - Strata 2 (groundwater protection)	m	30	30	30	--	--	Site-specific values based on RI results and current water table elevation data
	Thickness - Strata 3 (groundwater protection)	m	23.2	23.2	23.2	--	--	Site-specific values based on RI results and current water table elevation data
	Soil density (Strata 1) (groundwater protection)	g/cm^3	1.98	1.98	1.98	--	1.45	Hanford formation gravel-dominated sequence
	Soil density (Strata 2) (groundwater protection)	g/cm^3	1.5	1.5	1.5	--	--	Hanford formation sand-dominated sequence and Cold Creek unit
	Soil density (Strata 3) (groundwater protection)	g/cm^3	2.23	2.23	2.23	--	--	Ringold Unit E silty sandy gravel
	Total porosity/effective porosity (Strata 1) (groundwater protection)	unitless	0.253	0.253	0.253	0.27/ 0.23	0.39	Site-specific value based on RI results and BHI-01177
	Total porosity/effective porosity (Strata 2) (groundwater protection)	unitless	0.435	0.435	0.435	--	--	Site-specific values based on physical property samples from RI and WHC-EP-0883
	Total porosity/effective porosity (Strata 3) (groundwater protection)	unitless	0.158	0.158	0.158	--	--	Site-specific values based on physical property samples from RI and WHC-EP-0883
	Field capacity (groundwater protection)	unitless	0.04	0.04	0.04	--	1.00E-34	Site-specific values based on physical property samples from RI and WHC-EP-0883
	Soil-specific parameter (groundwater protection)	unitless	4.05	4.05	4.05	4.05	4.05	RESRAD Table E:2; CCN 070578

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
	Hydraulic conductivity (Strata 1) (groundwater protection)	m/yr	757	757	757	700	5520	--
	Hydraulic conductivity (Strata 2) (groundwater protection)	m/yr	138	138	138	--	--	--
	Hydraulic conductivity (Strata 3) (groundwater protection)	m/yr	552	552	552	--	--	WHC-SD-EN-SE-004
R016 - Distribution coefficients and leach rates for individual radionuclides	Distribution coefficients (K_d) for contaminated zone, uncontaminated zone, and saturated zone	mL/g	Am-241: 300 Co-60: 1200 Cs-137: 1500 Cm-244: 100 Eu-152/154/155: 300 H-3: 0 Na-22: 10 Ni-63: 300 Np-237: 15 Pu-238/239/240: 200 Ra-226/228: 20 Sr-90: 20 Tc-99: 0 Th-228/230/232: 1000 U-232/234/235/238: 3 Sb-125: 0 Se-79: 0				Am-241: 3 C-14: 0 Co-60: 0 Cs-137: 10 Eu-152/154/155: 3 H-3: 0 Ni-63: 5 Np-237: 5 Pu-238/239/240: 3 Ra-226/228: 5 Sr-90: 5 Tc-99: 0 Th-228/230/232: 3 U-232/234/235/238: 0.4	PNNL-11800
	Saturated leach rate	L/year	0	0	0	0	0	RESRAD default

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
R017 - Inhalation and external gamma	Inhalation rate	m^3/yr	7300	7300	7300	7300	7300	WDOH/320-015
	Mass loading for inhalation	g/m^3	0.0001	0.0001	0.0001	0.0001	0.0001	WDOH/320-015
	Exposure duration	yr	30	30	30	20	30	WAC 173-340-750 and EPA/540/R-92/003
	Inhalation shielding factor	unitless	0.4	0.4	0.4	0.4	0.4	RESRAD default
	External gamma shielding factor	unitless	0.8	0.8	0.8	0.8	0.8	WDOH/320-015
	Indoor time fraction (Industrial Scenario)	unitless	0.137	0.137	0.137	0.137	0.137	200 Area Industrial scenario; 8,760 h/yr, for calculation of indoor fraction onsite (60% of 2,000 h/yr)
	Outdoor time fraction (Industrial Scenario)	unitless	0.091	0.091	0.091	0.091	0.091	200 Area Industrial scenario; 8,760 h/y, for calculation of outdoor fraction onsite (40% of 2,000 h/yr)
	Shape factor	unitless	1	1	1	1	1	RESRAD default
R018 - Ingestion pathway data, dietary parameters	Soil ingestion (industrial, direct contact)	g/yr	36.5	36.5	36.5	36.5	36.5	WDOH/320-015
	Drinking water intake	L/yr	Not used	Not used	Not used	Not used	Not used	WDOH/320-015
	Drinking water intake	L/yr	730	730	730	730	730	Assumes drinking a volume of 2 L/day
	Drinking water contamination fraction	unitless	Not used	Not used	Not used	Not used	Not used	RESRAD default
	Drinking water contamination fraction	unitless	1	1	1	1	1	Assumes that all of the water is contaminated groundwater

Table C-9. Parameters Used for RESRAD Analysis. (8 Pages)

Description	Parameter	Units	216-U-10 Pond	216-U-14 Ditch	216-Z-11 Ditch	216-A-25 Pond	216-T-26 Crib	Rationale and Citation
R019 - Ingestion pathway data, non-dietary parameters	Depth of soil mixing layer	m	0.15	0.15	0.15	0.15	0.15	RESRAD default
	Groundwater fractional use - drinking water	unitless	Not used	Not used	Not used	Not used	Not used	RESRAD default
	Groundwater fractional use - drinking water	unitless	1	1	1	1	1	Assumes that all of the water used is groundwater

10 CFR 835, "Occupational Radiation Protection."

BHI-01177, *Borehole Summary Report for the 216-B-2-2 Ditch.*

CCN 070578, "Estimation of the Soil-Specific Exponential Parameter(s)."

DOE/RL-90-07, *Remedial Investigation/Feasibility Study Work Plan for the 100-BC-1 Operable Unit, Hanford Site, Richland, Washington.*

DOE/RL-99-66, *200-CW-5 U-Pond/Z Ditches Cooling Water Group Operable Unit RI/FS Work Plan.*

DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

EPA 540/R-92/003, *Risk Assessment Guidance for Superfund: Volume I -- Human Health Evaluation Manual (Part B. Development of Risk-Based Preliminary Remediation Goals).*

PNNL-11800, *Composite Analysis for Low-Level Waste Disposal in the 200 Area Plateau of the Hanford Site.*

Resource Conservation and Recovery Act of 1976, 42 USC 6901, et seq.

WAC 173-340-750, "Cleanup Standards to Protect Air Quality."

WDOH/320-015, *Hanford Guidance for Radiological Cleanup.*

WHC-EP-0883, *Variability and Scaling of Hydraulic Properties for 200 Area Soils, Hanford Site.*

WHC-SD-EN-SE-004, *Site Characterization Report: Results of Detailed Evaluation of the Suitability of the Site Proposed for Disposal of 200 Areas Treated Effluent.*

-- = not available.
bgs = below ground surface.
CZ = contaminated zone.
DC = direct contact.
EPA = U.S. Environmental Protection Agency.
GWP = groundwater protection.
K_d = distribution coefficient.
ND = nondispersion.
RCRA = *Resource Conservation and Recovery Act of 1976.*
RESRAD = RESidual RADioactivity (dose model).
RI = remedial investigation.
SZ = saturated zone.
WIDS = *Waste Information Data System.*

Table C-10. RESRAD Dose Results – Without Cover. (2 pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
Industrial, No Cover, Direct Contact	**216-Z-11 Ditch**				
	4.5×10^4	0	plutonium-239	58%	Ground
			radium-226	24%	
	4.5×10^4	1	plutonium-239	58%	Ground
			radium-226	24%	
	4.4×10^4	50	plutonium-239	59%	Ground
			radium-226	24%	
	4.2×10^4	150	plutonium-239	61%	Ground
			radium-226	23%	
	4.2×10^4	200	plutonium-239	61%	Ground
			radium-236	23%	
	4.0×10^4	300	plutonium-239	63%	Ground
			radium-226	22%	
	3.9×10^4	400	plutonium-239	64%	Ground
			radium-226	21%	
	3.8×10^4	500	plutonium-239	66%	Ground
			radium-226	20%	
	3.4×10^4	1,000	plutonium-239	71%	Ground
			radium-226	16%	
	216-U-10 Pond				
	2.7×10^3	0	cesium-137	98%	Ground
	2.6×10^3	1	cesium-137	98%	Ground
	850	50	cesium-137	98%	Ground
	95	150	cesium-137	87%	Ground
	38	200	cesium-137	68%	Ground
	14	300	thorium-232	23%	Ground
			plutonium-239	20%	
			cesium-137	19%	
	11	400	thorium-232	30%	Ground
			plutonium-239	25%	
			potassium-40	16%	
	10	500	thorium-232	32%	Ground
			plutonium-239	27%	
			potassium-40	15%	
	8.2	1,000	thorium-232	39%	Ground
			radium-239	32%	

Table C-10. RESRAD Dose Results – Without Cover. (2 pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
Industrial, No Cover	**216-U-14 Ditch**				
	1.4×10^3	0	cesium-137	100%	Ground
	1.4×10^3	1	cesium-137	100%	Ground
	440	50	cesium-137	99%	Ground
	47	150	cesium-137	92%	Ground
	17	200	cesium-137	80%	Ground
	4.5	300	potassium-40	37%	Ground
			cesium-137	30%	
			radium-226	25%	
	3.0	400	potassium-40	49%	Ground
			radium-226	35%	
	2.7	500	potassium-40	49%	Ground
			radium-226	37%	
	1.8	1,000	radium-226	37%	Ground
			potassium-40	43%	
	216-A-25 Gable Mountain Pond				
	310	0	cesium-137	99%	Ground
	300	1	cesium-137	99%	Ground
	97	50	cesium-137	100%	Ground
	9.8	150	cesium-137	99%	Ground
	3.2	200	cesium-137	93%	Ground
	0.62	300	cesium-137	49%	Ground
			thorium-230	49%	
	0.43	400	thorium-230	90%	Ground
	0.48	500	thorium-230	98%	Ground
	0.82	1,000	thorium-230	99%	Ground

Table C-11. RESRAD Risk Results – Without Cover. (2 pages)

Scenario	Total Risk	Time	Primary	Percentage of	Primary Pathway
Industrial, No Cover, Direct Contact	**216-Z-11 Ditch**				
	0.28	0	plutonium -239	24%	Ground
			radium-226	66%	
	0.28	1	plutonium -239	24%	Ground
			radium-226	66%	
	0.27	50	plutonium -239	25%	Ground
			radium-226	67%	
	0.25	150	radium-226	66%	Ground
			plutonium -239	26%	
	0.25	200	radium-226	65%	Ground
			plutonium -239	27%	
	0.24	300	radium-226	64%	Ground
			plutonium -239	28%	
	0.22	400	radium-226	63%	Ground
			plutonium -239	30%	
	0.21	500	radium-226	62%	Ground
			plutonium -239	31%	
	0.17	1,000	radium-226	55%	Ground
			plutonium-239	38%	
	216-U-10 Pond				
	0.036	0	cesium-137	100%	Ground
	0.035	1	cesium-137	99%	Ground
	0.011	50	cesium-137	99%	Ground
	1.3×10^{-3}	150	cesium-137	89%	Ground
	4.9×10^{-4}	200	cesium-137	72%	Ground
	1.7×10^{-4}	300	cesium-137	21%	Ground
			potassium-40	21%	
			radium-226	16%	
	1.3×10^{-4}	400	thorium-228	28%	Ground
			potassium-40	24%	
			radium-226	20%	
	1.2×10^{-4}	500	thorium-228	31%	Ground
			radium-226	20%	
			potassium-40	23%	
	9.6×10^{-5}	1,000	thorium-228	38%	Ground
			radium-228	20%	
			radium-226	19%	

Table C-11. RESRAD Risk Results – Without Cover (2 pages).

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
Industrial, No Cover, Direct Contact	**216-U-14 Ditch**				
	0.019	0	cesium-137	100%	Ground
	0.018	1	cesium-137	100%	Ground
	5.9×10^{-3}	50	cesium-137	99%	Ground
	2.4×10^{-4}	150	cesium-137	91%	Ground
	6.4×10^{-4}	200	cesium-137	77%	Ground
	6.7×10^{-5}	300	potassium-40	42%	Ground
			radium-226	29%	
			cesium-137	27%	
	4.7×10^{-5}	400	potassium-40	55%	Ground
			radium-226	39%	
	4.1×10^{-5}	500	potassium-40	56%	Ground
			radium-226	41%	
	2.6×10^{-5}	1,000	potassium-40	51%	Ground
			radium-226	45%	
	216-A-25 Gable Mountain Pond				
	3.1×10^{-3}	0	cesium-137	99%	Ground
	3.0×10^{-3}	1	cesium-137	99%	Ground
	9.7×10^{-4}	50	cesium-137	100%	Ground
	9.8×10^{-5}	150	cesium-137	98%	Ground
	3.3×10^{-5}	200	cesium-137	92%	Ground
	6.5×10^{-6}	300	cesium-137	46%	Ground
			thorium-230	53%	
	4.8×10^{-6}	400	thorium-230	93%	Ground
	5.5×10^{-6}	500	thorium-230	99%	Ground
	9.5×10^{-6}	1,000	thorium-230	100%	Ground

Table C-12. RESRAD Dose Results – With Cover. (2 Pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
Industrial, Cover, Direct Contact	**216-Z-11 Ditch**				
	0.043	0	radium-226	99%	Ground
	0.044	1	radium-226	99%	Ground
	0.077	50	radium-226	100%	Ground
	0.25	150	radium-226	100%	Ground
	0.45	200	radium-226	100%	Ground
	1.5	300	radium-226	100%	Ground
	4.7	400	radium-226	100%	Ground
	15	500	radium-226	100%	Ground
	3.4×10^4	1000	plutonium-239	71%	Soil Ingestion
	216-U-10 Pond				
	0.52	0	cesium-137	95%	Ground
	0.51	1	cesium-137	95%	Ground
	0.33	50	cesium-137	97%	Ground
	0.16	150	cesium-137	79%	Ground
	0.14	200	cesium-137	59%	Ground
			potassium-40	15%	
	0.22	300	potassium-40	27%	Ground
			cesium-137	16%	
			radium-226	16%	
	0.58	400	thorium-232	49%	Ground
			potassium-40	29%	
			radium-226	19%	
	3.0	500	thorium-232	31%	Ground
			plutonium-239	30%	
			potassium-40	15%	
	8.2	1,000	thorium-232	39%	Ground
			plutonium-239	32%	
			radium-226	11%	

Table C-12. RESRAD Dose Results – With Cover. (2 Pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
Industrial, Cover, Direct Contact	**216-U-14 Ditch**				
	0.0	0	--	--	Ground
	0.0	1	--	--	Ground
	0.0	50	--	--	Ground
	0.0	150	--	--	Ground
	0.0	200	--	--	Ground
	0.0	300	--	--	Ground
	0.0	400	--	--	Ground
	0.0	500	--	--	Ground
	0.0	1,000	--	--	Ground
	216-A-25 Gable Mountain Pond				
	0.0	0	--	--	Ground
	0.0	1	--	--	Ground
	0.0	50	--	--	Ground
	0.0	150	--	--	Ground
	0.0	200	--	--	Ground
	0.0	300	--	--	Ground
	0.0	400	--	--	Ground
	0.0	500	--	--	Ground
	0.90	1,000	thorium-230	91%	Ground

Table C-13. RESRAD Risk Results – With Cover. (2 Pages)

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
Industrial, Cover, Direct Contact	**216-Z-11 Ditch**				
	9.2×10^{-7}	0	radium-226	99%	Ground
	9.3×10^{-7}	1	radium-226	99%	Ground
	1.7×10^{-6}	50	radium-226	100%	Ground
	5.3×10^{-6}	150	radium-226	100%	Ground
	9.6×10^{-6}	200	radium-226	100%	Ground
	3.1×10^{-5}	300	radium-226	100%	Ground
	1.0×10^{-4}	400	radium-226	100%	Ground
	3.3×10^{-4}	500	radium-226	100%	Ground
	1.7×10^{-1}	1000	radium-226	55%	Ground
	216-U-10 Pond				
	8.2×10^{-6}	0	cesium-137	97%	Ground
	8.1×10^{-6}	1	cesium-137	97%	Ground
	5.4×10^{-6}	50	cesium-137	96%	Ground
	2.8×10^{-6}	150	cesium-137	75%	Ground
	2.6×10^{-6}	200	cesium-137	52%	Ground
	4.4×10^{-6}	300	thorium-228	32%	Ground
			potassium-40	28%	
			radium-226	17%	
	1.2×10^{-5}	400	thorium-228	36%	Ground
			potassium-40	28%	
			radium-226	20%	
	4.1×10^{-5}	500	thorium-232	32%	Ground
			potassium-40	23%	
	9.6×10^{-5}	1,000	thorium-228	38%	Ground
			radium-226	19%	
			radium-228	20%	
	216-U-14 Ditch				
	0.0	0	--	--	Ground
	0.0	1	--	--	Ground
	0.0	50	--	--	Ground
	0.0	150	--	--	Ground
	0.0	200	--	--	Ground
	0.0	300	--	--	Ground
	0.0	400	--	--	Ground
	0.0	500	--	--	Ground
	0.0	1,000	--	--	Ground

Table C-13. RESRAD Risk Results – With Cover. (2 Pages)

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
	216-A-25 Gable Mountain Pond				
Industrial, Cover, Direct Contact	0.0	0	--	--	Ground
	0.0	1	--	--	Ground
	0.0	50	--	--	Ground
	0.0	150	--	--	Ground
	0.0	200	--	--	Ground
	0.0	300	--	--	Ground
	0.0	400	--	--	Ground
	0.0	500	--	--	Ground
	1.5×10^{-5}	1,000	thorium-230	95%	Ground

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
216-Z-11 Ditches[b]								
nitrite	CONV	mg/kg	43	NA	NA	NA		Requires further evaluation[c]
arsenic	METAL	mg/kg	6.2	20	No	7	No	Below background
barium	METAL	mg/kg	88	132	No	102	No	Below Soil Indicator Value[e]
beryllium	METAL	mg/kg	0.25	1.5	No	NA	No	Below background
boron	METAL	mg/kg	24	NA	NA	NA		Requires further evaluation[c]
cadmium	METAL	mg/kg	0.050	1.0	No	14	No	Below background
chromium	METAL	mg/kg	11	18.5	No	67	No	Below background
copper	METAL	mg/kg	30	22	Yes	217	No	Below Soil Indicator Value
hexavalent chromium	METAL	mg/kg	0.54	NA	NA	67	No	Below Soil Indicator Value
lead	METAL	mg/kg	7.1	10	No	118	No	Below background
magnesium	METAL	mg/kg	4,760	NA	NA	NA	No	Requires further evaluation[c]
mercury	METAL	mg/kg	0.66	0.33	Yes	5.5	No	Below Soil Indicator Value
molybdenum	METAL	mg/kg	0.77	NA	NA	7	No	Below Soil Indicator Value
nickel	METAL	mg/kg	11	19.1	No	980	No	Below background
silver	METAL	mg/kg	0.69	0.73	No	NA	No	Below background
vanadium	METAL	mg/kg	58	85.1	No	NA	No	Below background
zinc	METAL	mg/kg	63	67.8	No	360	No	Below background

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
Aroclor-1254	PEST/PCB	mg/kg	52	NA	NA	NA		Requires further evaluation[c]
Aroclor-1260	PEST/PCB	mg/kg	78	NA	NA	NA		Requires further evaluation[c]
216-U-10 (U-Pond)[b]								
aluminum	METAL	mg/kg	9,476	11,800	No	NA	No	Below background
antimony	METAL	mg/kg	6.1	NA	NA	NA		Requires further evaluation[c]
arsenic	METAL	mg/kg	4.2	20	No	7	No	Below background
barium	METAL	mg/kg	126	132	No	102	No	Below background
beryllium	METAL	mg/kg	0.55	1.5	No	NA	No	Below background
cadmium	METAL	mg/kg	1.6	1.0	Yes	14	No	Below Soil Indicator Value
chromium	METAL	mg/kg	18	18.5	No	67	No	Below background
cobalt	METAL	mg/kg	13	15.7	No	NA	No	Below background
copper	METAL	mg/kg	31	22.0	Yes	217	No	Below Soil Indicator Value
cyanide	METAL	mg/kg	0.15	NA	NA	NA		Requires further evaluation[c]
iron	METAL	mg/kg	22,564	32,600	No	NA	No	Below background
lead	METAL	mg/kg	20	10.2	Yes	118	No	Below Soil Indicator Value
manganese	METAL	mg/kg	457	512	No	1500	No	Below background
mercury	METAL	mg/kg	0.18	0.33	No	5.5	No	Below Soil Indicator Value

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
nickel	METAL	mg/kg	22	19.1	Yes	980	No	Below Soil Indicator Value
selenium	METAL	mg/kg	0.39	NA	NA	0.3	Yes	Requires further evaluation[c]
silver	METAL	mg/kg	3.5	0.73	Yes	NA		Requires further evaluation[c]
thallium	METAL	mg/kg	0.35	0.3 to 0.6	Yes	NA		Requires further evaluation[c]
total uranium	METAL	mg/kg	29	3.21	Yes	NA		Requires further evaluation[c]
vanadium	METAL	mg/kg	55	85.1	No	NA	No	Below background
zinc	METAL	mg/kg	119	67.8	Yes	360	No	Below Soil Indicator Value
216-U-14 Ditch[b]								
antimony	METAL	mg/kg	6.5	NA	NA	NA		Requires further evaluation[c]
arsenic	METAL	mg/kg	1.4	20	No	7	No	Below background
barium	METAL	mg/kg	86	132	No	102	No	Below background
beryllium	METAL	mg/kg	0.29	1.5	No	NA	No	Below background
chromium	METAL	mg/kg	7.1	18.5	No	67	No	Below background
cobalt	METAL	mg/kg	7.1	15.7	No	NA	No	Below background
copper	METAL	mg/kg	15	22.0	No	217	No	Below background
lead	METAL	mg/kg	3.4	10.2	No	118	No	Below background
manganese	METAL	mg/kg	290	512	No	1500	No	Below background

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
nickel	METAL	mg/kg	6.2	19.1	No	980	No	Below background
silver	METAL	mg/kg	3.3	0.73	Yes	NA		Requires further evaluation[e]
vanadium	METAL	mg/kg	68	85.1	No	NA	No	Below background
zinc	METAL	mg/kg	44	67.8	No	360	No	Below background
216-T-26 Crib[c]								
cadmium	METAL	mg/kg	0.46	1.0	No	14	No	Below Background
chromium	METAL	mg/kg	10.8	18.5	No	67	No	Below Background
copper	METAL	mg/kg	14	22	No	217	No	Below Background
lead	METAL	mg/kg	10.1	10.2	No	118	No	Below Background
nickel	METAL	mg/kg	13	19.1	No	980	No	Below Background
total uranium	METAL	mg/kg	1.8	NA	NA	NA		Requires further evaluation[e]
216-A-25 Gable Mountain Pond[d]								
antimony	METAL	mg/kg	1	NA	NA	NA		Requires further evaluation[e]
arsenic	METAL	mg/kg	33.8	20	Yes	7	Yes	Requires further evaluation[e]
barium	METAL	mg/kg	140	132	Yes	102	Yes	Requires further evaluation[e]
cadmium	METAL	mg/kg	1.7	1.0	Yes	14	No	Below Soil Indicator Value

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
chromium, total	METAL	mg/kg	24.3	18.5	Yes	67	No	Below Soil Indicator Value
copper	METAL	mg/kg	58.8	22	Yes	217	No	Below Soil Indicator Value
lead	METAL	mg/kg	35.5	10.2	Yes	118	No	Below Soil Indicator Value
selenium	METAL	mg/kg	1.5	NA	NA	0.3	Yes	Requires further evaluation[c]
thallium	METAL	mg/kg	1.70	0.3 to 0.6	Yes	NA		Requires further evaluation[c]
uranium, total	METAL	mg/kg	2.19	NA	NA	NA		Requires further evaluation[c]
zinc	METAL	mg/kg	204	67.8	Yes	360	No	Below Soil Indicator Value
acetone	VOC	mg/kg	0.008	NA	NA	NA		Requires further evaluation[c]
2-Butanone (MEK)	VOC	mg/kg	0.002	NA	NA	NA		Requires further evaluation[c]
methylene chloride	VOC	mg/kg	0.032	NA	NA	NA		Requires further evaluation[c]
phenol (acid fraction)	VOC	mg/kg	0.033	NA	NA	NA		Requires further evaluation[c]
benzyl butyl phthalate	SVOC	mg/kg	0.16	NA	NA	NA		Requires further evaluation[c]

Table C-14. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background Concentrations and to Ecological Screening Levels for Nonradionuclides. (6 Pages)

Constituent Name	Constituent Class	Units	Exposure Point Concentration	90th Percentile Background Concentration	Does the EPC Exceed Background?	Soil Indicator Value[a] (Wildlife)	COEC?	Justification
diethyl phthalate	SVOC	mg/kg	0.088	NA	NA	NA		Requires further evaluation[e]
di-n-butyl phthalate	SVOC	mg/kg	1.8	NA	NA	NA		Requires further evaluation[e]

[a]WAC-173-340-900, "Tables," Table 749-3, "Ecological Indicator Soil Concentration (mg/kg) for Protection of Terrestrial Plants and Animals."

[b]Constituent statistics and analytical results from Table 5-39 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[c]Information from DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit).*

[d]Constituent statistics and analytical results from Tables 4-8 and 4-18 of DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.*

[e]This evaluation is provided in Section 2.8 of this feasibility study and includes the *Ecological Evaluation of the Hanford 200 Areas - Phase I: Compilation of Existing 200 Areas Ecological Data* (DOE/RL-2001-54) and the results of the ecological data quality objectives and sampling and analysis plan that will be created for the Central Plateau.

COEC = contaminant of ecological concern.
EPC = exposure point concentration.
NA = not available.
PEST/PCB = pesticide/polychlorinated biphenyl.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table C-15. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background and to Ecological Screening Values for Radionuclides (units in pCi/g). (5 Pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Exposure Point Concentration	90th Percentile Background Concentration	Exceeds Background?	Biota Concentration Guide[a]	COEC?	Justification
216-Z-11 Ditches[b]									
americium-241	286	284	99%	76,152	NA	U	4,000	Yes	Requires further evaluation[c]
cesium-137	187	184	98%	951	0.919	Yes	20	Yes	Requires further evaluation[c]
plutonium-238	62	54	87%	5,500	0.0047	Yes	5,400	Yes	Requires further evaluation[c]
plutonium-239	15	15	100%	780,000	NA	U	6,000	Yes	Requires further evaluation[c]
plutonium-239/240	268	266	99%	132,229	0.0192	Yes	6,000	Yes	Requires further evaluation[c]
radium-226	12	12	100%	5,200	0.815	Yes	50	Yes	Requires further evaluation[c]
radium-228	4	2	50%	0.81	NA	U	40	No	Below BCG
strontium-90	30	23	77%	23	0.167	Yes	20	Yes	Requires further evaluation[c]
thorium-228	4	1	25%	0.66	NA	U	NA		Requires further evaluation[c]
thorium-232	4	1	25%	0.71	1.32	No	2,000	No	Below background
uranium-233/234	4	1	25%	0.36	1.1	No	5,000	No	Below background
uranium-238	4	2	50%	0.77	1.1	No	5,000	No	Below background

Table C-15. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background and to Ecological Screening Values for Radionuclides (units in pCi/g). (5 Pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Exposure Point Concentration	90th Percentile Background Concentration	Exceeds Background?	Biota Concentration Guide[a]	COEC?	Justification
216-U-10 (U-Pond)[b]									
americium-241	19	17	89%	44	NA	U	4,000	No	Below BCG
cesium-137	19	18	95%	3,994	0.919	Yes	20	Yes	Requires further evaluation[c]
cobalt-60	19	6	32%	16	0.008	Yes	700	No	Below BCG
europium-152	19	5	26%	0.43	NA	U	NA		Requires further evaluation[c]
europium-154	19	3	16%	12	0.033	Yes	1,000	No	Below BCG
europium-155	19	2	11%	1.7	0.054	Yes	20,000	No	Below BCG
neptunium-237	19	3	16%	0.28	NA	U	NA		Requires further evaluation[c]
plutonium-238	19	9	47%	22	0.005	Yes	5,400	No	Below BCG
plutonium-239/240	19	16	84%	75	0.0192	Yes	6,000	No	Below BCG
potassium-40	19	19	100%	15	16.6	No	NA	No	Below background
radium-226	15	14	93%	0.90	0.815	Yes	50	No	Below BCG
radium-228	13	13	100%	0.99	NA	U	40	No	Below BCG
selenium-79	19	9	47%	10	NA	U	NA		Requires further evaluation[c]
strontium-90	19	17	89%	157	0.167	Yes	20	Yes	Requires further evaluation[c]
technetium-99	19	6	32%	8.8	NA	U	4,000	No	Below BCG
thorium-228	3	2	67%	0.038	NA	U	2,200	No	Below BCG
thorium-232	14	14	100%	2.6	1.32	Yes	2,000	No	Below BCG
uranium-233/234	3	3	100%	85	1.1	Yes	5,000	No	Below BCG
uranium-235	19	10	53%	1.1	0.11	Yes	3,000	No	Below BCG
uranium-238	19	19	100%	88	1.1	Yes	2,000	No	Below BCG

Table C-15. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background and to Ecological Screening Values for Radionuclides (units in pCi/g). (5 Pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Exposure Point Concentration	90th Percentile Background Concentration	Exceeds Background?	Biota Concentration Guide[a]	COEC?	Justification
216-U-14 Ditch[b]									
americium-241	25	13	52%	1.6	NA	U	4,000	No	Below BCG
antimony-125	1	1	100%	0.10	NA	U	10,000	No	Below BCG
cesium-137	34	21	62%	2,228	0.919	Yes	20	Yes	Requires further evaluation[c]
cobalt-60	22	8	36%	0.62	0.0084	Yes	700	No	Below BCG
plutonium-238/239	12	12	100%	2.1	0.0047	Yes	5,400	No	Below BCG
plutonium-239/240	1	1	100%	10	0.019	Yes	6,000	No	Below BCG
radium-226	9	6	67%	0.66	0.815	No	50	No	Below background
strontium-90	30	17	57%	5.2	0.167	Yes	20	No	Below BCG
technetium-99	1	1	100%	12	NA	U	4,000	No	Below BCG
total uranium	13	13	100%	350	1.1	Yes	5,000	No	Below BCG
uranium-235	9	4	44%	0.13	0.11	Yes	3,000	No	Below BCG
uranium-238	12	12	100%	1.1	1.1	No	2,000	No	Below background
216-T-26 Crib[c]									
potassium-40	1	1	100%	8.5	17	No	NA	No	Below background
radium-226	1	1	100%	0.37	0.815	No	3.0	No	Below background
radium-228	1	1	100%	0.34	1.3	No	2.0	No	Below background
thorium-228	1	1	100%	0.94	1.3	No	2,200	No	Below background
thorium-230	1	1	100%	0.74	1.1	No	2,700	No	Below background

Table C-15. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background and to Ecological Screening Values for Radionuclides (units in pCi/g). (5 Pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Exposure Point Concentration	90th Percentile Background Concentration	Exceeds Background?	Biota Concentration Guide[a]	COEC?	Justification
thorium-232	1	1	100%	0.74	1.3	No	2,000	No	Below background
uranium-233/234	1	1	100%	0.46	1.1	No	5,000	No	Below background
uranium-238	1	1	100%	0.34	1.1	No	2,000	No	Below background
216-A-25 Gable Mountain Pond[d]									
americium-241	70	7	10 %	1.28	NA	U	4,000	No	Below BCG
cesium-137	70	39	56 %	7,180	0.919	Yes	20	Yes	Requires further evaluation[e]
cobalt-60	70	4	6 %	0.118	0.008	Yes	700	No	Below BCG
europium -154	70	11	16%	3.37	0.033	Yes	1,000	No	Below BCG
europium -155	70	3	4%	1.18	0.054	Yes	20,000	No	Below BCG
plutonium-239/240	46	5	11%	1.14	0.0192	Yes	6,000	No	Below BCG
potassium-40	70	65	97%	19.6	16.6	Yes	NA		Requires further evaluation[e]
radium-226	70	56	80%	1.43	0.815	Yes	50	No	Below BCG
radium-228	70	59	84%	1.37	NA	U	40	No	Below BCG
strontium-90	70	27	39%	49.7	0.167	Yes	20	Yes	Requires further evaluation[e]
thorium-228	70	55	79%	1.17	NA	U	NA		Requires further evaluation[e]
thorium-230	46	33	72%	1.22	1.1	Yes	2,700	No	Below BCG
thorium-232	70	66	94%	1.26	1.32	No	2,000	No	Below background
uranium-233/234	4	4	100%	0.858	1.1	No	5,000	No	Below background

Table C-15. Comparison of Shallow-Zone Soil Exposure Point Concentrations to Background and to Ecological Screening Values for Radionuclides (units in pCi/g). (5 Pages)

Constituent Name	Number of Samples	Number of Detects	Frequency of Detection	Exposure Point Concentration	90th Percentile Background Concentration	Exceeds Background?	Biota Concentration Guide[a]	COEC?	Justification
uranium-235	70	3	4%	0.293	0.11	Yes	3,000	No	Below BCG
uranium-238	70	4	6%	4.03	1.1	Yes	2,000	No	Below BCG

[a]DOE-STD-1153-2002, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, Table 6.4.

[b]Constituent statistics and analytical results from Table 5-40 of DOE/RL-2003-11, *Remedial Investigation Report or the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[c]Information from DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit).*

[d]Constituent statistics and analytical results from Table 4-22 of DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.*

[e]This evaluation is provided in Section 2.8 of this feasibility study and includes the *Ecological Evaluation of the Hanford 200 Areas - Phase I: Compilation of Existing 200 Areas Ecological Data* (DOE/RL-2001-54) and the results of the ecological data quality objectives and sampling and analysis plan that will be created for the Central Plateau.

BCG = biota concentration guide.
COEC = contaminant of ecological concern.
NA = not available.
U = undetermined.

Table C-16. Comparison of True Mean Deep-Zone Soil Concentrations from the 216-Z-11 Ditch to Soil Risk-Based Concentrations for Groundwater Protection.[a]

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	GWP RBC[b]	Does True Mean Exceed GWP RBC?
CONV	nitrite (as NO_2)	mg/kg	3	3	100%	33	13	Yes
METAL	boron	mg/kg	11	11	100%	2.9	11	No
METAL	total chromium	mg/kg	11	11	100%	11	2,000	No
METAL	copper	mg/kg	11	11	100%	16	263	No
METAL	hexavalent chromium	mg/kg	10	4	40%	0.47	18	No
METAL	mercury	mg/kg	11	2	18%	0.075	2.1	No
METAL	molybdenum	mg/kg	11	10	91%	1.0	16	No
PEST/PCB	Aroclor-1254	mg/kg	11	1	9%	4.7	0.99	Yes
PEST/PCB	Aroclor-1260	mg/kg	11	1	9%	7.1	8.2	No
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	10	3	30%	0.14	14	No
VOC	acetone	mg/kg	10	10	100%	0.0075	29	No
VOC	methylene chloride	mg/kg	10	9	90%	0.0060	0.025	No

[a] Constituent statistics and analytical results from Table 5-26 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] WAC 173-340-745 calculation or CLARC Version 3.1, Table, Method C.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*

WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

CONV	=	conventional parameter.
GWP	=	groundwater protection.
PEST/PCB	=	pesticide/polychlorinated biphenyl.
RBC	=	risk-based concentration.
SVOC	=	semivolatile organic compound.
VOC	=	volatile organic compound.

Table C-17. Comparison of True Mean Deep-Zone Soil Concentrations from the 216-U-10 Pond to Soil Risk-Based Concentrations for Groundwater Protection.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	GWP RBC[b]	Does True Mean Exceed GWP RBC?
CONV	nitrogen in nitrite and nitrate	mg/kg	29	16	55%	16	40	No
METAL	antimony	mg/kg	29	2	7%	5.0	5.4	No
METAL	barium	mg/kg	29	29	100%	104	923	No
METAL	cadmium	mg/kg	29	4	14%	0.90	0.69	Yes
METAL	chromium	mg/kg	29	29	100%	13	18	No
METAL	cobalt	mg/kg	29	29	100%	12	868	No
METAL	copper	mg/kg	29	25	86%	20	263	No
METAL	cyanide	mg/kg	29	2	7%	0.61	0.80	No
METAL	lead	mg/kg	29	29	100%	11	3,000	No
METAL	manganese	mg/kg	29	29	100%	398	50	Yes
METAL	mercury	mg/kg	29	3	10%	0.11	2.1	No
METAL	nickel	mg/kg	29	29	100%	16	130	No
METAL	silver	mg/kg	29	23	79%	2.1	14	No
METAL	thallium	mg/kg	29	5	17%	0.28	1.6	No
METAL	uranium	mg/kg	29	28	97%	19	1.3	Yes
METAL	zinc	mg/kg	29	29	100%	73	5,971	No
PEST/PCB	Aroclor-1254	mg/kg	16	1	6%	0.020	0.99	No
PEST/PCB	Aroclor-1260	mg/kg	16	2	13%	0.028	8.2	No
PEST/PCB	DDD	mg/kg	16	1	6%	0.0020	0.34	No
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	29	3	10%	0.30	14	No
VOC	1,1,1-trichloroethane	mg/kg	16	1	6%	0.0054	1.6	No
VOC	2-butanone	mg/kg	16	1	6%	0.0081	22	No
VOC	acetone	mg/kg	16	2	13%	0.018	29	No
VOC	carbon disulfide	mg/kg	16	1	6%	0.0056	5.7	No

Table C-17. Comparison of True Mean Deep-Zone Soil Concentrations from the 216-U-10 Pond to Soil Risk-Based Concentrations for Groundwater Protection.[a] (2 Pages)

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	GWP RBC[b]	Does True Mean Exceed GWP RBC?
VOC	chloroform	mg/kg	16	3	19%	0.0048	0.038	No
VOC	toluene	mg/kg	16	2	13%	0.0060	7.3	No

[a] Constituent statistics and analytical results from Table 5-27 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[b] WAC 173-340-745, CLARC Version 3.1, Table, Method C or calculations.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

CONV = conventional parameter.
GWP = groundwater protection.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table C-18. Comparison of True Mean Deep-Zone Soil Concentrations from the 216-U-14 Ditch to Soil Risk-Based Concentrations for Groundwater Protection.[a]

Constituent Class	Constituent Name	Units	Number of Samples	Number of Detects	Frequency of Detection	Average Detected Result	GWP RBC[b]	Does True Mean Exceed GWP RBC?
METAL	antimony	mg/kg	13	4	31%	2.1	5.4	No
METAL	nickel	mg/kg	17	17	100%	13	130	No
METAL	silver	mg/kg	15	6	40%	1.2	14	No
METAL	thallium	mg/kg	8	1	13%	0.017	1.6	No
PEST/PCB	Aroclor-1254	mg/kg	6	1	25%	0.0016	0.99	No
SVOC	bis(2-ethylhexyl) phthalate	mg/kg	4	1	100%	0.028	14	No
VOC	2-butanone	mg/kg	3	3	100%	0.040	22	No
VOC	acetone	mg/kg	4	2	50%	0.032	29	No
VOC	methylene chloride	mg/kg	9	9	100%	0.0016	0.025	No

[a]Constituent statistics and analytical results from Table 5-28 of DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*
[b]WAC 173-340-745, CLARC Version 3.1, Table, Method C or calculations.

Ecology 94-145, *Model Toxics Control Act Cleanup Levels & Risk Calculations (CLARC) Version 3.1.*
WAC 173-340-745, "Soil Cleanup Standards for Industrial Properties."

GWP = groundwater protection.
PEST/PCB = pesticide/polychlorinated biphenyl.
RBC = risk-based concentration.
SVOC = semivolatile organic compound.
VOC = volatile organic compound.

Table C-19. Comparison of Deep-Zone Soil Concentrations from the 216-A-25 Gable Mountain Pond to Soil Risk-Based Concentrations for Groundwater Protection.*

Contaminant	Units	Number of Samples	Number of Detects	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	95 % UCL Conc.	GWP Method B	Does 95% UCL Exceed GWP Method B?	Do More than 10% Exceed GWP Method B?	Does More than 1 Sample Exceed 2X GWP Method B?
acetone	mg/kg	68	45	66%	0.002	0.008	0.0043	80	No	No	No
antimony	mg/kg	96	32	33%	0.19	1	0.213	0.6	No	No	No
benzyl butyl phthalate	mg/kg	68	5	7%	0.033	0.16	0.16	320	No	No	No
bis(2-ethylhexyl) phthalate	mg/kg	68	1	1%	0.059	0.059	0.059	0.625	No	No	No
chloromethane	mg/kg	68	2	3%	0.005	0.006	5.43×10^{-3}	0.337	No	No	No
diethyl phthalate	mg/kg	68	6	9%	0.05	0.088	0.354	1280	No	No	No
di-n-butyl phthalate	mg/kg	68	17	25%	0.017	1.8	0.088	160	No	No	No
2-butanone (MEK)	mg/kg	68	11	16%	0.001	0.002	0.002	480	No	No	No
methylene chloride	mg/kg	68	68	100%	0.004	0.032	0.0153	0.583	No	No	No
phenol (acid fraction)	mg/kg	68	8	12%	0.018	0.033	0.033	960	No	No	No
selenium	mg/kg	103	64	62%	0.29	1.5	0.546	5	No	No	No
thallium	mg/kg	96	73	76%	0.43	1.7	0.735	0.128	Yes	Yes	No
toluene	mg/kg	68	1	1%	0.001	0.001	0.001	100	No	No	No
uranium, total	mg/kg	70	70	100%	0.328	2.19	0.754	2	No	No	No
xylenes, total	mg/kg	68	1	1%	0.002	0.002	0.002	100	No	No	No

Constituent statistics and analytical results from Table 4-15 of DOE/RL-2000-35, *200-CW-1 Operable Unit Remedial Investigation Report.

UCL = upper confidence limit.
GWP = groundwater protection.

Table C-20. RESRAD Dose Results for Groundwater Protection.* (2 Pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
Groundwater Protection, No Cover	**216-Z-11 Ditch**				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	0.0	50	--	--	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-U-10 Pond				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	48	36	selenium-79	96%	Drinking Water
	3.10	50	selenium-79	96%	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-U-14 Ditch				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	43	35	technetium-99	100%	Drinking Water
	4.9	50	technetium-99	100%	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-T-26 Crib				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	0.0	50	--	--	Drinking Water

Table C-20. RESRAD Dose Results for Groundwater Protection.* (2 Pages)

Scenario	Total Dose (mrem/yr)	Time (years)	Primary Radionuclide	Percentage of Total Dose	Primary Pathway
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-A-25 Gable Mountain Pond				
	0.021	0	technetium-99	99%	Drinking Water
	0.064	1	technetium-99	99%	Drinking Water
	1.9	50	technetium-99	98%	Drinking Water
	3.5	108	technetium-99	98%	Drinking Water
	2.8	150	technetium-99	97%	Drinking Water
	2.1	200	technetium-99	95%	Drinking Water
	1.3	300	technetium-99	87%	Drinking Water
	0.86	400	technetium-99	73%	Drinking Water
	0.64	500	technetium-99	55%	Drinking Water
			potassium-40	45%	
	0.59	1,000	potassium-40	97%	Drinking Water

*RESRAD calculation assumed no soil cover.

RESRAD = ANL/EAD-4, *Users Manual for RESRAD Version 6.*

Table C-21. RESRAD Risk Results for Groundwater Protection.* (2 Pages)

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
Groundwater Protection, No Cover	**216-Z-11 Ditch**				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	0.0	50	--	--	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-U-10 Pond				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	2.1×10^{-4}	36	selenium-79	96%	Drinking Water
	1.4×10^{-5}	50	selenium-79	96%	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-U-14 Ditch				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water
	3.1×10^{-4}	35	technetium-99	100%	Drinking Water
	3.5×10^{-5}	50	technetium-99	100%	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-T-26 Crib				
	0.0	0	--	--	Drinking Water
	0.0	1	--	--	Drinking Water

Table C-21. RESRAD Risk Results for Groundwater Protection.* (2 Pages)

Scenario	Total Risk	Time (years)	Primary Radionuclide	Percentage of Total Risk	Primary Pathway
	0.0	50	--	--	Drinking Water
	0.0	150	--	--	Drinking Water
	0.0	200	--	--	Drinking Water
	0.0	300	--	--	Drinking Water
	0.0	400	--	--	Drinking Water
	0.0	500	--	--	Drinking Water
	0.0	1,000	--	--	Drinking Water
	216-A-25 Gable Mountain Pond				
	1.8×10^{-5}	0	technetium-99	99%	Drinking Water
	1.9×10^{-5}	1	technetium-99	99%	Drinking Water
	6.7×10^{-5}	50	technetium-99	99%	Drinking Water
	7.3×10^{-5}	150	technetium-99	97%	Drinking Water
	5.6×10^{-5}	200	technetium-99	95%	Drinking Water
	3.4×10^{-5}	300	technetium-99	89%	Drinking Water
	2.2×10^{-5}	400	technetium-99	77%	Drinking Water
	1.5×10^{-5}	500	technetium-99	60%	Drinking Water
			potassium-40	40%	
	1.3×10^{-5}	1,000	potassium-40	96%	Drinking Water

*RESRAD calculation assumed no soil cover.

RESRAD = ANL/EAD-4, *Users Manual for RESRAD Version 6.*

Table C-22. Contaminants Modeled with STOMP.[a]

216-Z-11 Ditch[b]	216-U-10 Pond[b]	216-U-14 Ditch[b]	216-T-26 Crib[c]
americium-241	cesium-137	cesium-137	americium-241
cesium-137	plutonium-239/240	plutonium-239/240	cesium-137
plutonium-239	selenium-79	strontium-90	europium-154
plutonium-239/240	strontium-90	technetium-99	europium-155
strontium-90	technetium-99	antimony	hydrogen-3
thorium-230	thorium-228	sulfide	plutonium-238
Aroclor-1254	thorium-232	uranium (total)	plutonium-239/240
Aroclor-1260	uranium-233/234		strontium-90
	uranium-234		technetium-99
	uranium-235		uranium-233/234
	uranium-238		uranium-235
	antimony		uranium-238
	cadmium		cyanide
	cyanide		nitrate
	fluoride		nitrite
	kerosene		
	nitrate		
	sulfate		
	uranium (total)		

[a]STOMP modeling was not performed for representative site 216-A-25 Gable Mountain Pond.

[b]From DOE/RL-2003-11, *Remedial Investigation Report for the 200-CW-5 U Pond/Z Ditches Cooling Water Group, the 200-CW-2 S Pond and Ditches Cooling Water Group, the 200-CW-4 T Pond and Ditches Cooling Water Group, and the 200-SC-1 Steam Condensate Group Operable Units.*

[c]From DOE/RL-2002-42, *Remedial Investigation Report for the 200-TW-1 and 200-TW-2 Operable Units (Includes the 200-PW-5 Operable Unit).*

STOMP = PNNL-12034, *STOMP, Subsurface Transport Over Multiple Phases, Version 2.0, User's Guide.*

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APPENDIX D

COST ESTIMATE BACKUP

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CONTENTS

FIGURES

TABLES

Tables are provided at the end of the appendix (the table of contents will be generated at a later date).

TERMS

CERCLA	*Comprehensive Environmental Response, Compensation, and Liability Act of 1980*
ERDF	Environmental Restoration Disposal Facility
FS	feasibility study
G&A	general and administrative
HEPA	high-efficiency particulate air (filter)
HIC	high-integrity container
IDW	investigation derived waste
LLDPE	linear low-density polyethylene
LLW	low-level waste
OMB	Office of Management and Budget
PFP	Plutonium Finishing Plant
PPE	personnel protection equipment
PVC	polyvinyl chloride
QA/QC	quality assurance and quality control
RA	remedial action
RCRA	*Resource Conservation and Recovery Act of 1976*
RCT	Radiation Control Technician
REDOX	reduction-oxidation
RI	remedial investigation
WIPP	Waste Isolation Pilot Plant
WRAP	Waste Receipt and Processing Facility

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APPENDIX D

COST ESTIMATE BACKUP

D1.0 INTRODUCTION

Cost estimates for the feasibility study (FS) have an accuracy of +50 percent, -30 percent, which is the accuracy specified in EPA/540/G-89/004, *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (Interim Final)*. The cost estimates provide a discriminator for deciding between similar protective and implementable alternatives for a specific waste site. Therefore, the costs are relational, not absolute, costs for the evaluation of the alternatives. Cost estimates were made by waste site with the exception of five groups that were developed based on logistics. One of the five groups is a representative site. Refer to Table D-63 for a listing of the group sites. This FS does not evaluate the economies associated with implementing multiple sites or groups with a common alternative or aggregated remediation. They will be considered in the future as part of long-range planning and through the post-record-of-decision activities, such as remedial design. Potential areas of cost sharing to reduce overall remediation costs include the following:

- Remediating all waste sites with a common preferred alternative at the same time
- Sharing mobilization/demobilization costs
- Sharing surveillance and maintenance costs
- Sharing barrier performance monitoring costs.

D2.0 ALTERNATIVE COST ESTIMATES

This chapter describes the cost estimates based on the remedial alternatives developed in Chapter 6.0 of the Feasibility Study (FS). This chapter also summarizes the alternatives considered and the total present-worth costs, and provides summary and backup information for costs by waste site or group.

Present-net-worth costs were estimated using the real discount rate published in Appendix C of the Office of Management and Budget (OMB) Circular No. A-94, *Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs*, which is effective through the end of January 2004. Programs with durations longer than 30 years use the 30-year interest rate of 3.2 percent. Present-net-worth costs are discussed for each alternative in the following subsections.

Non-discounted costs were calculated because of recommendations presented in EPA 540-R-00-002, OSWER 9355.0-75, July 2000. Non-discounted constant dollar costs demonstrate the impact of a discount rate on the total present value cost. The non-discounted costs are presented for comparison purposes only.

D2.1 ALTERNATIVE 1 – NO ACTION

The no-action alternative represents a situation where no legal restrictions, access controls, or active remedial measures are applied to the waste site. Taking no action implies "walking away from the waste site" and allowing the waste to remain in its current configuration, affected only by natural processes. No maintenance or other activities would be instituted or continued. Chapter 6.0 of the FS describes the no-action alternative.

Because the no-action alternative assumes no further actions will be taken at a waste site, costs are assumed to be zero.

D2.2 ALTERNATIVE 2 – MAINTAIN EXISTING SOIL COVER, MONITORED NATURAL ATTENUATION, AND INSTITUTIONAL CONTROLS

Chapter 6.0 of the FS provides a description of the Maintain Existing Soil Cover, Monitored Natural Attenuation, and Institutional Controls alternative. Cost models for each representative site are discussed in detail in Section D3.2. The primary costs associated with this alternative are surveillance and cover maintenance and monitored natural attenuation costs. This alternative also includes the cost of maintaining the existing soil cover. The costs for these controls were estimated based on the area of the individual waste sites or groups. Tables D-1 through D-20 provide details of the cost estimates.

The unit cost for surveillance and maintenance was assumed to be the same as the current unit cost for surveillance and maintenance activities conducted annually on the waste sites. The unit cost accounts for such activities as site radiation surveys, and repair of the existing soil cover on the sites where it is present. Because the existing soil cover is maintained annually, costs for replacing all or large portions of the existing cover at specified intervals (i.e., every 20 years) are considered unnecessary.

The costs associated with natural attenuation monitoring are divided into three components: radiological surveys of surface soils, spectral gamma logging of vadose zone boreholes, and groundwater monitoring. The costs to perform radiological surveys of surface soils at waste sites are assumed to be similar to those for current survey practices at the sites and are included in the surveillance and maintenance costs.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a 15 m (50 ft) depth once every 5 years until the site meets all preliminary remediation goals. This monitoring is considered for sites with high concentrations of contaminants in the shallow zone or near the bottom of crib and trench structures. It also assumes that the service life of vadose zone boreholes is 30 years. Costs are included for logging and periodic replacement of these boreholes until all preliminary remediation goals are met for the site.

Groundwater monitoring costs likely will be incurred for sites that have high concentrations of mobile contaminants deep within the vadose zone and/or where groundwater contamination is known to have occurred.

The cost model used for this alternative consisted of a simple spreadsheet. Durations were used for the representative sites based on the length of time required to reach preliminary remediation goals. Because the analogous sites do not have data to support the time needed to reach preliminary remediation goals, costs for institutional controls at analogous waste sites were estimated using the time from the associated representative site.

The present-net-worth costs for surveillance and maintenance and natural attenuation monitoring are added to the periodic costs to reach the total present-worth cost for this alternative. The real discount rate of 3.2 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150 year project duration is presented for comparison purposes.

D2.3 ALTERNATIVE 3 – REMOVAL, TREATMENT, AND DISPOSAL

Chapter 6.0 of this FS describes the remove-and-dispose alternative. Cost models for each representative site are discussed in detail in Section D3.3. Cost estimate inputs for the removal, treatment, and disposal alternative are provided in Tables D-21 through D-30.

The table in Section D3.5 lists the excavation depths for this alternative. Institutional control costs were not added to the removal, treatment, and disposal alternative because the contaminants are assumed to be removed to concentrations at or below the preliminary remediation goals. This alternative removes the human health and ecological risks associated with the contaminated soils at each site evaluated in this FS.

All costs associated with the removal, treatment, and disposal alternative are present-net-worth costs.

D2.4 ALTERNATIVE 4 – CAPPING

Chapter 6.0 of this FS provides a description of the capping alternative. Cost models for each representative site are discussed in detail in Section D3.4. Cost estimate inputs for the capping alternative are included in Tables D-31 through D-50. Figure D-1 shows details of the assumed cap design for the modified Resource Conservation and Recovery Act (RCRA) Subtitle C barrier, assumed for all but the Z-Ditches. The Hanford Barrier is required for the Z-Ditches because of high TRU[1] concentrations.

Operation and maintenance costs for the capping alternative include barrier performance monitoring and repair costs. For purposes of this FS, annual repairs to the cap (replacement of 15.2 cm [2 ft] of topsoil layer and revegetation over 10 percent of the barrier area) are assumed. This is considered a conservative estimate because the barrier has been designed to require minimal maintenance, particularly after vegetation has been established. The real discount rate of 3.2 percent is used for discounting real (constant-dollar) flows for operation and maintenance

[1]Waste materials contaminated with 100 nCi/g of transuranic materials having half-lives longer than 20 years.

costs for the period until all preliminary remediation goals are reached at each site to obtain the present-net-worth cost for the alternative.

Institutional controls are an integral component of the capping alternative and would be required to prevent both intrusion to the capped area and activities that might alter the integrity and effectiveness of the cap. As part of the capping alternative, costs for dynamic compaction have been included to eliminate any void spaces within the site. This will ensure that a firm subgrade will be provided to prevent future cap settling.

The present-net-worth costs for the alternative are added to institutional control costs to reach the total present-worth cost for this alternative. The real discount rate of 3.2 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150 year project duration is presented for comparison purposes.

D2.5 ALTERNATIVE 5 – PARTIAL REMOVAL, TREATMENT, AND DISPOSAL WITH CAPPING

Chapter 6.0 of this FS provides a description of the removal, treatment, and disposal with capping alternative. Cost models for each representative site are discussed in detail in Section D3.5. Cost estimate inputs for this alternative are included in Tables D-51 through D-58.

Under Alternative 5, the removal of contaminants by excavation extends to a depth of 5 ft below the bottom point of greatest radionuclide activity, as shown in the table included in Section D3.5. The excavation would be filled with borrow material obtained on the Hanford Site. When the backfilling operation is finished, the site would be capped. These activities remove a significant fraction of the near-surface contaminant load and still provide protection to groundwater from deeper contaminants that are impractical to remove. The removal, treatment, disposal, and capping activities would be the same as described for Alternatives 3 and 4.

Most of the groundwater protection contaminants are located deeper in the vadose zone; therefore, the removal of contaminants from the zone shown on the table included in Section D3.5 would not significantly change the groundwater risk. The capping activity provided in this alternative would address protection of groundwater from the remaining contaminants in the vadose zone. Institutional controls would be required for this alternative because contamination remains on site above preliminary remediation goals.

The present-net-worth costs for the alternative are added to institutional control costs to reach the total present-worth cost for this alternative. The real discount rate of 3.2 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150 year project duration is presented for comparison purposes.

D2.6 ALTERNATIVE 6 – IN SITU VITRIFICATION

Chapter 6.0 of this FS provides a description of the in situ vitrification alternative. This alternative only is applicable to representative site 216-Z-11. Cost models for 216-Z-11 are discussed in detail in Section D3.6. Tables D-59 through D-62 include cost estimate inputs for this alternative.

In situ vitrification involves the electric melting of contaminated soils and debris to result in the destruction, removal, or permanent immobilization of contaminants. The melting process is initiated within a waste or soil mixture. Electrical power is directed to the treatment zone via graphite electrodes and regulated to maintain the desired melt rate. The melt temperature typically ranges from 1400 °C to 2000 °C depending on the materials being treated and the particular process configuration. The melt grows downward and outward until the electric power is shut off once the target waste volume has been treated.

Institutional controls have been included in this alternative to ensure that the vitrification process was successful.

The present-net-worth costs for the alternative are added to institutional control costs to reach the total present-worth cost for this alternative. The real discount rate of 3.2 percent is used for discounting real (constant-dollar) flows for the duration until all preliminary remediation goals are reached at each site. The non-discounted cost for the 150 year project duration is presented for comparison purposes.

D3.0 ASSUMPTIONS

The following sections document assumptions for the representative sites and selected analogous sites for Alternatives 2, 3, 4, 5, and 6.

D3.1 GLOBAL ASSUMPTIONS

D3.1.1 Labor

Each cost item described includes one, or a combination of, material costs, equipment costs, labor costs, and subcontract costs. In addition, each cost estimate contains a variety of markups. Labor rates and markups were developed for the contractor and Fluor Hanford personnel as follows.

Contractor: The contractor is assumed to be performing all the excavation, earth moving, construction, decontamination, and container-lining activities on site for each of the alternatives evaluated.

When the contractor performs work, costs are associated with support personnel, laborers, equipment operators, oilers, and truck drivers performing the work (rates obtained from Fluor Hanford):

- Support personnel
  - Superintendent = $50/hour
  - Site foreman = $50/hour
  - Site engineer = $50/hour
  - Site health and safety person = $50/hour
  - Timekeeper-clerk = $37/hour
- Construction
  - Equipment operator = $37/hour
  - Laborer = $37/hour
  - Truck driver (teamster) = $37/hour
  - Oiler = $37/hour.

In addition to on-site personnel, the contractor will have office staff. When contractor office support is referred to, the following is assumed (rate obtained from Fluor Hanford):

Office support, engineer = $50/hour.

Fluor Hanford: It is assumed that Flour Hanford personnel will perform construction oversight and annual inspections. When construction oversight is used, it shall refer to the following individuals at the following rates (rates obtained from Fluor Hanford):

- Project management and oversight = $75/hour
- Radiation control technician (RCT) = $56/hour
- Health and safety personnel = $56/hour
- Quality assurance, quality control (QA/QC), and scheduling = $56/hour
- Field engineer = $56/hour
- Sample technician = $56/hour.

D3.1.2 Markups

The following markups (obtained from Fluor Hanford) will be added as indicated:

- Fluor Hanford
  - General and administrative (G&A) on labor, materials, and equipment 15% each
- Contractor
  - G&A on labor, materials, and equipment 26.5%
  - Direct markup on labor 25%

– Direct markup on material	10%
– Direct markup on subcontractors	10%
– Fluor Hanford markup on contractor G&A	15%
• Contingency	25%

D3.1.3 General Assumptions

The following general assumptions also apply to all of the cost estimates.

- All of the cost estimates include costs associated with the alternative starting with construction mobilization. Although the cost estimates do include annual operation and maintenance-type costs if applicable and costs associated with preparing closeout documents, the cost estimates do not include costs for design, work plan preparation, or any other preparation costs normally associated with activities occurring before field mobilization.

- When costing equipment rental rates, it is assumed that each month contains 21 days.

- When costing equipment operation, the cost is based on an 8-hour day.

- When calculating project durations, it is assumed that a week consists of 5 days.

- When a borrow material in the cost tables appears with no cost in the material column, it is assumed that the borrow material will be obtained from an on-site borrow source. If a borrow material appears with cost in the material column, it is assumed that the material will be purchased from an outside source.

D3.1.4 Long-Term Groundwater Monitoring Costs

Under each alternative that includes annual inspections and maintenance costs (Alternatives 2, 4, 5, and 6) there will be a cost for periodic groundwater monitoring. The cost associated with periodic groundwater monitoring is distributed equally over applicable closure zones. The following is a description of the periodic groundwater costs.

Periodic groundwater sampling will be performed in each closure zone located at the facility. Each closure zone will contain three monitoring wells that will be sampled during the periodic sampling event. The present worth cost for the periodic groundwater monitoring program will be the same for each closure zone. That cost then will be divided equally among the sites within that closure zone. A summary of the facility closure zones associated with this FS is presented below.

Closure Zone	Number of Sites in Each Closure Zone
200-W-Ponds	28
T Plant	49
Reduction-Oxidation (REDOX)	47

U Plant	39
Plutonium Finishing Plant (PFP)	36
T Farm	58
PUREX	72
B Plant	56

Based on historical information from similar Hanford Site planning, the cost to install a compliant monitoring well is approximately $180,000 per well. It is assumed that this cost includes all required labor and material.

Cost to install wells (3 wells) = $180,000/well x 3 wells

= $540,000

Maintenance will need to be performed on each of the wells every 6 years during the 150-year active monitoring period. In addition, each of the wells will need to be replaced once every 25 years.

Maintenance costs (3 wells) = $5,000/well x 3 wells

= $15,000 every 6 years

Replacement costs (3 wells) = $180,000/well x 3 wells

= $540,000 every 25 years

During each sampling event, three groundwater samples will be collected for analysis. The analyses and cost per analysis is listed below.

Tc-99	= $234/sample x 3 samples/event	= $702/event
Total Uranium	= $73/sample x 3 samples/event	= $219/event
Nitrate	= $270/sample x 3 samples/event	= $810/event
Cs-137	= $180/sample x 3 samples/event	= $540/event
Sr-90 as total radiostrontium	= $353/sample x 3 samples/event	= $1,059/event
Isotopic Pu	= $364/sample x 3 samples/event	= $1,092/event
Total analytical cost per sampling event		= $4,422

The labor cost of doing all the paper work, labeling, monitoring, and delivery to the laboratory is approximately $300 per well sampled.

Total labor cost = $300/well x 3 wells

= $900/sampling event

Total cost to collect and analyze samples per sampling event = $5,322

Sampling events will occur at the following frequencies:

Year 1	Quarterly (4 sampling events)
Year 2	Semi-annually (2 sampling events)
Years 3 through 5	Annually (3 sampling events)
Years 6 through 10	Every 2 years (3 sampling events)
Years 11 through 50	Every 5 years (8 sampling events)
Years 51 through 150	Every 10 years (10 sampling events).

The present worth cost to conduct a periodic groundwater monitoring program for each closure zone for 150 years was calculated.

Present worth cost for long-term groundwater program (discounted) = $1,127,888

As a comparison, the non-discounted present worth cost for long-term groundwater program was calculated to compare the effect of a discount rate on the total project cost.

Present worth non-discounted costs for long-term groundwater program = $3,759,660

The present worth cost, on a per site basis, will be added to the calculated and ratio costs presented in Table D-65. Because there is a different number of sites in each closure zone, the following table presents the long-term groundwater monitoring cost per site for each closure zone. The non-discounted long-term groundwater monitoring cost per site is presented in parentheses.

Closure Zone	Number of Sites in Each Closure Zone	Cost Per Site
200-W-Ponds	28	$40,282 ($134,274)
T Plant	49	$23,018 ($76,728)
REDOX	47	$23,998 ($79,993)
U Plant	39	$28,920 ($96,402)
PFP	36	$31,330 ($104,435)
T Farm	58	$19,446 ($64,822)
PUREX	72	$15,665 ($52,218)
B Plant	56	$20,141 ($67,137)

Lastly, the following table lists the sites include in this FS, their associated closure zone, and the cost that will be added into the costs for Alternatives 2, 4, 5, and 6 presented on Table D-65. Non-discounted costs are presented in parentheses.

Closure Zone: 200-W-Ponds — Cost per Site: $40,282 ($134,274)

216-U-9 Ditch	216-U-10 Pond
216-U-11 Ditch	216-U-14 Ditch
216-S-17 Pond	216-S-16P Pond
207-S Retention Basin	216-S-172 Control Structure
2904-S-160 Control Structure	2904-S-171 Control Structure
216-S-16D Ditch	UPR-200-W-124
216-S-5 Crib	216-S-6 Crib
216-S-25 Crib	207-A North Retention Basin

Closure Zone: T Plant — Cost per Site: $23,018 ($76,728)

207-U Retention Basin	216-W-LWC Crib
UPR-200-W-111	UPR-200-W-112
200-W-102 Process Sewer	216-T-1 Ditch
207-T Retention Basin	200-W-79 Pipeline

Closure Zone: REDOX — Cost per Site: $23,998 ($79,993)

2904-S-170 Control Structure	

Closure Zone: U Plant — Cost per Site: $28,920 ($96,402)

200-W-84 Process Sewer	216-T-4A Pond
216-T-4B Pond	

Closure Zone: PFP — Cost per Site: $31,330 ($104,435)

216-Z-1D Ditch	216-Z-19 Ditch
UPR-200-W-110	216-Z-20 Ditch
216-Z-11 Ditch	207-Z Retention Basin

Closure Zone: T Farm — Cost per Site: $19,446 ($64,822)

216-T-4-1D Ditch	216-T-4-2 Ditch
200-W-88 Process Sewer	216-T-12 Trench
216-T-36 Crib	

Closure Zone: PUREX — Cost per Site: $15,665 ($52,218)

216-A-6 Crib	216-A-30 Crib
UPR-200-E-19	UPR-200-E-21
200-E-113 Process Sewer	216-A-37-2 Crib

Closure Zone: B Plant — Cost per Site: $20,141 ($67,137)

UPR-200-E-29	216-B-55 Crib
216-B-64 Retention Basin	

D3.2 ALTERNATIVE 2 – MAINTAIN EXISTING SOIL COVER, MONITORED NATURAL ATTENUATION, AND INSTITUTIONAL CONTROLS

D3.2.1 General Assumptions

The general assumptions for Alternative 2 are as follows:

- Unlike the cost estimates for Alternatives 3, 4, and 5, Alternative 2 costs were calculated for each of the sites (Representative and Analogous). Because it is not practical to present backup for all of the sites, cost descriptions were only developed for the Representative Sites. Using the processes presented in the Representative Site cost backup text presented here in Appendix D, equations were used to calculate the cost for each Analogous Site using the area of each Analogous Site. These calculated costs are presented in Table D-65.
- Site areas range from 900 to 2,660,000 ft^2. Because of this difference, larger construction crews will be used for sites larger than 100,000 ft^2. For example, existing cover maintenance will use five trucks to haul material to the site for areas greater than 100,000 ft^2 and one truck for sites less than 100,000 ft^2.
- Fencing and monuments/signs for institutional controls and fencing maintenance are considered institutional costs and are not considered in this cost estimate.
- Periodic groundwater monitoring costs will be added to Table D-65 as indicated in Section D3.1.4.
- Alternative 2 consists of five general activities: implementation of institutional controls, site inspection and surveillance, existing cover maintenance, natural attenuation monitoring, and site reviews. These activities are described for the representative sites in the following sections.
- The prices that make up the cost estimate were obtained from one of the following sources:
  - *ECHOS Environmental Remediation Cost Data – Unit Price*, 10th Annual Edition (Means, 2004a).
  - *Site Work and Landscape Cost Data*, 23rd Annual Edition (Means, 2004b).
  - Experience on similar projects.

D3.2.2 Representative Site 216-U-10 Pond (Cost tables D-1 through D-4)

Institutional Controls Implementation: Preparing and implementing institutional controls is a capital cost and includes office or administrative costs to implement deed restrictions, land-use restrictions, and groundwater-use restrictions. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/hour (assumption)

Site Inspection and Surveillance: The cost associated with site inspection and surveillance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The activities performed under site inspection and surveillance include radiation surveys of surface soil and physical site inspection. Activities may include control of deeply burrowing animals and deep-rooted plants by using herbicide or by physical removal (cost for these items are not included).

Site radiation surveys: For costing purposes, sites 5,000 ft^2 or smaller are assumed to cost \$1,000 for ever surveying event. An additional \$1,000 will be required for site radiation surveys for every additional 5,000 ft^2 of site area.

- Area of representative site = 1,306,500 ft^2 (see table D-63)
- Radiation surveys of surface soil = \$261,000/event (\$1,000/5,000 ft^2).

Physical site inspection: For costing purposes, sites 12,500 ft^2 or smaller are assumed to take two inspectors two hours to inspect. An additional two hours will be required for site inspections for every 12,500 ft^2 of site area.

The cost for site inspection and surveillance is based on the following.

- Area of representative site = 1,306,500 ft^2 (see Table D-63)
- Number of two-hour increments = 1,306,500 ft^2 / 12,500 ft^2 = 105
- Time to complete inspection = 26.25 days (2 hours for every 12,500 ft^2)
  = \$56/hour x 8 hours/day x 2 people
  = \$896/day.

Existing Cover Maintenance: The cost associated with existing cover maintenance is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. Because cover maintenance is performed annually, including costs for replacing all or large portions of the existing cover at specified intervals is unnecessary. Rather, cover maintenance is assumed to include replacing cover soils over 10 percent of the area to a depth of 2 ft. The soil used to repair the existing cover is a silt loam and pea gravel mixture. The pea gravel is used to make the soil resistant to wind erosion.

For costing purposes, it is assumed that the silt loam can be acquired for no material cost from an on-site borrow source and that pea gravel must be purchased at an offsite location. It is also assumed that both materials (silt loam and pea gravel) must be transported, blended, and placed at the site. For purchased pea gravel, the material cost includes transportation to the site. For the silt loam, costs are incurred for excavating the material from the on-site borrow source and transporting the material to the site. Once the pea gravel and silt loam are on site, there is an additional a cost to place and blend the material.

For representative sites whose area are greater than 100,000 ft^2, it is assumed for silt loam excavation, that one excavator, one front end loader, and two operators will excavate and load the silt loam into dump trucks for transportation to the site. To transport the silt loam to the site, it is assumed that five dump trucks and five drivers will be used and each dump truck will be able to make 2 trips an hour to the site carrying 16 yd^3 per trip (160 yd^3 / hour).
For representative sites less than 100,000 ft^2 in size, one excavator with one operator will directly load 1 truck for a production rate of 32 yd^3/hour.

Once the material is at the site it is assumed that the silt loam will be placed on site in a loose lift and then the pea gravel will be place on top of the silt loam. The silt loam and pea gravel will be spread at a rate equal to 1 part pea grave to 9 parts silt loam. While the pea gravel is placed on the silt loam a tiller will be used to blend the silt loam and pea gravel. It is assumed that the pea gravel and silt loam can be placed and blended at a rate equal to the delivery of the silt loam. For sites with areas less than 100,000 ft^2 a loader, dozer with tiller attachment, and two operators will be used to spread and blend the silt loam and pea gravel. For sites with areas greater than 100,000 ft^2, a loader, two bull dozers with tiller attachments, and three operators will be used to spread and blend the silt loam and pea gravel. Once the silt loam and pea gravel is in place these areas will need to be vegetated.

In addition to the material, transportation, blending, placement, and vegetation costs, it is assumed that Fluor Hanford will have a site engineer on site during cover maintenance activities to provide oversight.

Costs for cover maintenance are based on the following:

• Area of representative site	= 1,306,500 ft^2
• Area requiring repair (10% of total area)	= 130,650 ft^2 or 14,520 yd^2
• Volume of soil needed to repair cover	= 130,650 ft^2 x 2 ft / 27 ft^3/yd^3
	= 9,680 yd^3
• Volume of pea gravel (10% of soil)	= 968 yd^3
• Volume of silt loam needed	= 9,680 yd^3 – 968 yd^3 = 8,712 yd^3
• Pea gravel (material and transportation)	= $55.67/$yd^3$
• Silt loam (on-site borrow source excavate	= $37/hour (labor) x 8 hours/day x 2
/load) (160 yd^3/hour excavator & loader)	= $592/day + equipment rental
• Silt loam (transport)	= $37/hour (labor) x 8 hours/day
(160 yd^3/hour using 5 trucks)	= $296/day/driver + rental
• Silt loam/pea gravel place and blend	= $37/hour (labor) x 8 hours/day x 3
(160 yd^3/hour loader & 2 dozers)	= $888/day + equipment rental
• Time required to place soil	= 7 days
• Vegetation (vegetate 1,000 yd^2/day)	= $1.63/$yd^2$ (Means, 2004b)
• Time required for vegetation	= 14,520 yd^2 / 1,000 yd^2/day = 15 day
• Oversight (one person, one day)	= $56/hour (labor) x 8 hours/day
	= $448/day.

- Time for Oversight = 7 days + 15 days = 22 days.

Monitoring for Natural Attenuation: The cost associated with natural attenuation monitoring is an operation and maintenance cost. This cost will be incurred annually as long as the alternative is being used. The cost for natural attenuation monitoring includes spectral gamma logging of vadose zone boreholes.

Vadose zone monitoring costs assume spectral gamma logging of one borehole per waste site to a depth of 50 ft once every 5 years. The service life of a vadose zone borehole is assumed to be 30 years. Therefore, every 30 years a replacement borehole will be drilled. Costs are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = $75/ft x 50 ft = $3,750
- Installation cost of borehole = $50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours ($56/hour).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of investigation derived waste (IDW).

Reporting: Annual and periodic activities will be recorded in an annual report. The report will contain descriptions of activities that occurred during the year. Reports will contain all appropriate/required backup and material purchase information. The cost for the annual reports is based on the following assumption:

- Annual reports = $10,000/report.

Site Reviews: The cost associated with site reviews is an operation-and-maintenance cost. This cost will be incurred every 5 years as long as the alternative is being used. Site reviews will be conducted to assess site conditions and to evaluate the selected alternative and determine whether additional steps toward remediation are required. The cost for the five year site reviews is based on the following assumption:

- 5-year site review = $20,000/review.

D3.2.3 Representative Site 216-U-14 Ditch (Cost tables D-5 through D-8)

Institutional Controls Implementation: Refer to the institutional controls implementation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = $56/hour (assumption).

Site Inspection and Surveillance: Refer to the site inspection and surveillance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The costs for site inspection and radiation survey are based on the following.

- Area of representative site = 22,800 ft^2 (see table D-63)
- Number of two-hour increments = 22,800 ft^2 / 12,500 ft^2 = 2
- Time to complete site inspection = 0.5 day (2 hours for every 12,500 ft^2)
  = \$56/hour x 8 hours/day x 2 people
  = \$896/day
- Radiation surveys of surface soil = \$5,000/event (\$1,000/5,000 ft^2).

Existing Cover Maintenance: Refer to the existing cover maintenance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of the activities performed during maintenance of the existing cover. Costs for cover maintenance are based on the following:

- Area of representative site = 22,800 ft^2
- Area requiring repair (10% of total area) = 2,280 ft^2 or 253 yd^2
- Volume of soil needed to repair cover = 2,280 ft^2 x 2 ft / 27 ft^3/yd^3
  = 170 yd^3
- Volume of pea gravel (10% of soil) = 17 yd^3
- Volume of silt loam needed = 170 yd^3 – 17 yd^3 = 153 yd^3
- Pea gravel (material and transportation) = \$55.67/yd^3
- Silt loam (on-site borrow source excavate/ load) (32 yd^3/hour 1 excavator) = \$37/hour (labor) x 8 hours/day
  = \$296/day + equipment rental
- Silt loam (transport) (32 yd^3/hour using 1 truck) = \$37/hour (labor) x 8 hours/day
  = \$296/day + equipment rental
- Silt loam/pea gravel place and blend (32 yd^3/hour loader & dozer) = \$37/hour (labor) x 8 hours/day x 2
  = \$592/day + equipment rental
- Time required to place soil = 1 day
- Vegetation (vegetate 1,000 yd^2/day) = \$1.63/yd^2 (Means, 2004b)
- Time required for vegetation = 253 yd^2 / 1,000 yd^2/day = 1 day
- Oversight (one person, one day) = \$56/hour (labor) x 8 hours/day
  = \$448/day.
- Time for Oversight = 1 day + 1 day = 2 days.

Monitoring for Natural Attenuation: Refer to the monitoring for natural attenuation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs for natural attenuation monitoring are based on the following:

- Unit cost for vadose zone monitoring = \$75/ft of borehole
- Length of borehole drilling = 50 ft

- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/hour).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Refer to the annual report discussion presented und Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: Refer to the site review discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the five year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

D3.2.4 Representative Site 216-Z-11 Ditch (Cost tables D-9 through D-12)

Representative Site 216-Z-11 Ditch is a group site that contains Sites 216-Z-11, 216-Z-1D, 216-Z-19, UPR-200-W-110, and 216-Z-20. The composite area for this group of sites is 72,900 ft^2 [(2,765 ft x 24 ft) + (1,635 ft x 4 ft)].

Institutional Controls Implementation: Refer to the institutional controls implementation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/hour (assumption).

Site Inspection and Surveillance: Refer to the site inspection and surveillance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The costs for site inspection and radiation survey are based on the following.

- Area of representative site = 72,900 ft^2 (see table D-63)
- Number of two-hour increments = 72,900 ft^2 / 12,500 ft^2 = 6
- Time to complete site inspection = 1.5 days (2 hours for every 12,500 ft^2)
  = \$56/hour x 8 hours/day x 2 people
  = \$896/day
- Radiation surveys of surface soil = \$15,000/event (\$1,000/5,000 ft^2).

Existing Cover Maintenance: Refer to the existing cover maintenance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of the activities performed during maintenance of the existing cover. Costs for cover maintenance are based on the following:

- Area of representative site = 72,900 ft^2
- Area requiring repair (10% of total area) = 7,290 ft^2 or 810 yd^2
- Volume of soil needed to repair cover = 7,290 ft^2 x 2 ft / 27 ft^3/yd^3 = 540 yd^3
- Volume of pea gravel (10% of soil) = 54 yd^3
- Volume of silt loam needed = 540 yd^3 – 54 yd^3 = 486 yd^3
- Pea gravel (material and transportation) = \$55.67/yd^3
- Silt loam (on-site borrow source excavate /load) (32 yd^3/hour 1 excavator) = \$37/hour (labor) x 8 hours/day = \$296/day + equipment rental
- Silt loam (transport) (32 yd^3/hour using 1 truck) = \$37/hour (labor) x 8 hours/day = \$296/day + equipment rental
- Silt loam/pea gravel place and blend (32 yd^3/hour loader & dozer) = \$37/hour (labor) x 8 hours/day x 2 = \$592/day + equipment rental
- Time required to place soil = 2 days
- Vegetation (vegetate 1,000 yd^2/day) = \$1.63/yd^2 (Means, 2004b)
- Time required for vegetation = 810 yd^2 / 1,000 yd^2/day = 1 day
- Oversight (one person, one day) = \$56/hour (labor) x 8 hours/day = \$448/day.
- Time for Oversight = 2 days + 1 day = 3 days.

Monitoring for Natural Attenuation: Refer to the monitoring for natural attenuation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs for natural attenuation monitoring are based on the following:

- Unit cost for vadose zone monitoring = \$75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = \$75/ft x 50 ft = \$3,750
- Installation cost of borehole = \$50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours (\$56/hour).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Refer to the annual report discussion presented und Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: Refer to the site review discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the five year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

D3.2.5 Representative Site 216-A-25 Gable Mountain Pond (Cost tables D-13 through D-16)

Institutional Controls Implementation: Refer to the institutional controls implementation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/hour (assumption).

Site Inspection and Surveillance: Refer to the site inspection and surveillance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The costs for site inspection and radiation survey are based on the following.

- Area of representative site = 2,660,000 ft^2 (see table D-63)
- Number of two-hour increments = 2,660,000 ft^2 / 12,500 ft^2 = 213
- Time to complete site inspection = 53.25 days (2 hours for every 12,500 ft^2)
  = \$56/hour x 8 hours/day x 2 people
  = \$896/day
- Radiation surveys of surface soil = \$532,000/event (\$1,000/5,000 ft^2).

Existing Cover Maintenance: Refer to the existing cover maintenance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of the activities performed during maintenance of the existing cover. Costs for cover maintenance are based on the following:

- Area of representative site = 2,660,000 ft^2
- Area requiring repair (10% of total area) = 266,000 ft^2 or 29,555 yd^2
- Volume of soil needed to repair cover = 266,000 ft^2 x 2 ft / 27 ft^3/yd^3
  = 19,703 yd^3
- Volume of pea gravel (10% of soil) = 1,970 yd^3
- Volume of silt loam needed = 19,703 yd^3 – 1,970 yd^3 = 17,733 yd^3
- Pea gravel (material and transportation) = \$55.67/yd^3
- Silt loam (on-site borrow source excavate/ = \$37/hour (labor) x 8 hours/day x 2

load) (160 yd^3/hour excavator & loader)	= \$592/day + equipment rental
• Silt loam (transport)	= \$37/hour (labor) x 8 hours/day
(160 yd^3/hour using 5 trucks)	= \$296/day/driver + rental
• Silt loam/pea gravel place and blend	= \$37/hour (labor) x 8 hours/day x 3
(160 yd^3/hour loader & 2 dozers)	= \$888/day + equipment rental
• Time required to place soil	= 16 days
• Vegetation (vegetate 1,000 yd^2/day)	= \$1.63/yd^2 (Means, 2004b)
• Time required for vegetation	= 29,555 yd^2/1,000 yd^2/day = 30 days
• Oversight (one person, one day)	= \$56/hour (labor) x 8 hours/day
	= \$448/day.
• Time for Oversight	= 16 days + 30 days = 46 days.

Monitoring for Natural Attenuation: Refer to the monitoring for natural attenuation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs for natural attenuation monitoring are based on the following:

• Unit cost for vadose zone monitoring	= \$75/ft of borehole
• Length of borehole drilling	= 50 ft
• Cost of vadose zone monitoring	= \$75/ft x 50 ft = \$3,750
• Installation cost of borehole	= \$50/linear ft
• Length of borehole installation	= 50 ft
• Oversight (assumption)	= 1 day = 8 hours (\$56/hour).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Refer to the annual report discussion presented und Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the annual reports is based on the following assumption:

- Annual reports = \$10,000/report.

Site Reviews: Refer to the site review discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the five year site reviews is based on the following assumption:

- 5-year site review = \$20,000/review.

D3.2.6 Representative Site 216-T-26 Crib (Cost tables D-17 through D-20)

Institutional Controls Implementation: Refer to the institutional controls implementation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs presented in the cost estimates are based on the following:

- Time to produce institutional controls = 200 hours (assumption)
- Labor rate = \$56/hour (assumption).

Site Inspection and Surveillance: Refer to the site inspection and surveillance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The costs for site inspection and radiation survey are based on the following.

- Area of representative site = 900 ft^2 (see table D-63)
- Number of two-hour increments = 900 ft^2 / 12,500 ft^2 = 1
- Time to complete site inspection = 0.25 day (2 hours for every 12,500 ft^2)
  = \$56/hour x 8 hours/day x 2 people
  = \$896/day
- Radiation surveys of surface soil = \$1,000/event (\$1,000/5,000 ft^2).

Existing Cover Maintenance: Refer to the existing cover maintenance discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of the activities performed during maintenance of the existing cover. Costs for cover maintenance are based on the following:

- Area of representative site = 900 ft^2
- Area requiring repair (10% of total area) = 90 ft^2 or 10 yd^2
- Volume of soil needed to repair cover = 90 ft^2 x 2 ft / 27 ft^3/yd^3
  = 7 yd^3
- Volume of pea gravel (10% of soil) = 1 yd^3
- Volume of silt loam needed = 7 yd^3 – 1 yd^3 = 6 yd^3
- Pea gravel (material and transportation) = \$55.67/yd^3
- Silt loam (on-site borrow source excavate/load) (32 yd^3/hour 1 excavator) = \$37/hour (labor) x 8 hours/day
  = \$296/day + equipment rental
- Silt loam (transport) (32 yd^3/hour using 1 truck) = \$37/hour (labor) x 8 hours/day
  = \$296/day + equipment rental
- Silt loam/pea gravel place and blend (32 yd^3/hour loader & dozer) = \$37/hour (labor) x 8 hours/day x 2
  = \$592/day + equipment rental
- Time required to place soil = 1 day
- Vegetation (vegetate 1,000 yd^2/day) = \$1.63/yd^2 (Means, 2004b)
- Time required for vegetation = 10 yd^2 / 1,000 yd^2/day = 1 day
- Oversight (one person, one day) = \$56/hour (labor) x 8 hours/day

= $448/day.

- Time for Oversight = 1 day + 1 day = 2 days

Monitoring for Natural Attenuation: Refer to the monitoring for natural attenuation discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. Costs for natural attenuation monitoring are based on the following:

- Unit cost for vadose zone monitoring = $75/ft of borehole
- Length of borehole drilling = 50 ft
- Cost of vadose zone monitoring = $75/ft x 50 ft = $3,750
- Installation cost of borehole = $50/linear ft
- Length of borehole installation = 50 ft
- Oversight (assumption) = 1 day = 8 hours ($56/hour).

Other costs associated with installing replacement boreholes are included on the cost estimate sheets. These items include, but are not limited to, mobilization of a drill rig, decontamination of a drill rig, and handling of IDW.

Reporting: Refer to the annual report discussion presented und Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the annual reports is based on the following assumption:

- Annual reports = $10,000/report.

Site Reviews: Refer to the site review discussion presented under Representative Site 216-U-10 (Section D3.2.2) for a description of associated activities. The cost for the five year site reviews is based on the following assumption:

- 5-year site review = $20,000/review.

D3.3 ALTERNATIVE 3 – REMOVAL, TREATMENT, AND DISPOSAL

D3.3.1 General Assumptions

The general assumptions for Alternative 3 are as follows:

- Following excavation of contaminated soil the operable unit will be considered clean and no periodic sampling, inspections, or institutional controls will be required for the site itself. As a result, all costs associated with Alternative 3 are capital cost; no annual costs are expected. Refer to the table in Section D3.5 for the excavation depths of each representative site.

- The contractor will perform all the excavation, decontamination, and restoration activities for this alternative. Personnel used to complete these tasks include support personnel, laborers, equipment operators, oilers, and truck drivers (teamsters). The support personnel will include a superintendent, a site foreman, a site engineer, a site health and safety manager, and a timekeeper-clerk. This support crew will be on site from mobilization through demobilization. Using the wages discussed in Section D3.1, this crew has an hourly rate of $237 ($1,896 daily rate). The number of laborers, equipment operators, oilers, and truck drivers are defined under the activities discussed in the following sections.

- Fluor Hanford will provide construction oversight, collect all samples, and perform all screening of material and containers leaving the site. Personnel used to perform construction oversight include a project manager, an RCT, a health and safety manager (half time), and a QA/QC representative and scheduler. This oversight crew will be used whenever the contractor is in operation. Using the wages discussed in Section D3.1, this crew has an hourly rate of $215 ($1,720 daily rate). Personnel used to perform all screening of material and containers leaving the site include one RCT for each excavator, one RCT accompanying each sampler, and four RCT for the decontamination pad. One RCT has been included in the contractor oversight crew as a substitute. RCTs have an hourly rate of $56 ($448/day).

- Air samples will be taken during excavation of overburden and contaminated soil. It is assumed that one air sample will be collected each day. The air sampling costs have been developed as follows:

- Equipment cost	=	$500 per day
- Analytical cost	=	$1,000 per sample
- Labor (sampler)	=	$56/hour (full time)
- Labor (RCT)	=	$56/hour (full time)
- Total labor	=	$896/day.

- Characterization samples will be taken from the overburden soil and contaminated soil as it is excavated. In addition, certification samples will be collected following excavation. The number of site certification samples collected is based on the total surface area of excavation, including the excavation floor and side slopes. The total number of off site QC samples equals 5% of the total number of samples collected. The soil sampling costs have been developed as follows:

- Overburden soil	Number of samples	=	6 samples per site
	Cost per sample	=	$1,100 each (on site)
		=	$5,000 each (off site)
	Labor (sampler)	=	$28/hour (half time)
	Labor (RCT)	=	$56/hour (full time)
	Total labor	=	$672/day
- Contaminated soil (LLW samples)	Number of samples	=	1 sample per 845 yd^3 (6 samples minimum)

	Cost per sample	=	\$5,000 each (on site)
		=	\$5,000 each (off site)
	Labor (sampler)	=	\$28/hour (half time)
	Labor (RCT)	=	\$56/hour (full time)
	Total labor	=	\$672/day
- Certification samples	Number of samples	=	1 sample per 6,264 ft^2 (6 samples minimum)
	Cost per sample	=	\$5,000 each (on site)
		=	\$5,000 each (off site)
	Labor (sampler)	=	\$56/hour (full time)
	Labor (RCT)	=	\$56/hour (full time)
	Total labor	=	\$896/day
	Sample collection	=	0.3 samples per hour.

- The cost for transportation and disposal of contaminated material at the ERDF is \$1,100 per container. This cost includes labor cost to install the liners in the containers, material cost for the liners, transportation to the ERDF, and ERDF storage costs. Cost for transportation to and disposal at the ERDF was obtained from DOE/EM-0387 "Profiles of Environmental Restoration CERCLA Disposal Facilities," July 1999.

- Soils being sent to the ERDF for disposal must meet the waste acceptance criteria of 50 mRem/hr on contact. An evaluation was performed using site data to determine the need for blending soils to meet the ERDF acceptance criteria. The results of the evaluation indicate that the only representative site that contains soils that exceed the ERDF acceptance criteria is Site 216-Z-11. A summary of the contact dose rates area as follows;

216-U-10 Pond	2.1 mRem/hr
216-U-14 Ditch	1.5 mRem/hr
216-Z-11 Ditch	429 mRem/hr
216-T-26 Crib	0.12 mRem/hr
216-A-25 Gable Mountain Pond	4.3 mRem/hr

  Further evaluation of 216-Z-11 indicates that a blending ratio of 8 parts clean to 1 part contaminated would be needed to meet the ERDF waste acceptance criteria. However, the soil layer that does not meet the waste acceptance criteria also exceeds the ERDF limit of 100 nCi/gm which means this material would need to be disposed at the Waste Isolation Pilot Plant (WIPP). Therefore, blending of clean soils with contaminated soils to meet ERDF acceptance criteria is not required for the 200-CW-5 Representative Sites.

- Representative sites with restoration volumes less than 100,000 yd^3 will use one hydraulic excavator and one front-end-loader at the on-site borrow source, five trucks to transport borrow soil to the site, and one front-end-loaders and one bulldozers onsite. To cut down on extended durations, representative site with restoration volumes greater than

100,000 yd^3 will use two hydraulic excavators and two front-end-loaders at the on-site borrow source, ten trucks to transport borrow soil to the site, and two front-end-loaders and two bulldozers onsite.

- The prices that make up the cost estimate were obtained from one of the following sources:
  - *ECHOS Environmental Remediation Cost Data – Unit Price*, 10th Annual Edition (Means, 2004a).
  - *Site Work and Landscape Cost Data*, 23rd Annual Edition (Means, 2004b).
  - Experience on similar projects.

D3.3.2 Representative Site 216-U-10 Pond (Cost tables D-21 and D-22)

The site work was estimated to take 3,949.2 weeks (940.3 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 15 days (3 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.
- Excavate: 12,922 days (2,584.4 weeks)
- Restore site: 6,799 days (1,359.8 weeks) (Includes vegetation time)
- Demobilize: 10 days (2 weeks), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 19,746 days = 3,949.2 weeks = 940.3 months.

Site Description: The basis for the following information can be found on Table D-63.

- Area of contaminant mass = 1,143 ft x 1,143 ft = 1,306,449 ft^2
- Depth of clean overburden soil = 2 ft bgs
- Total excavation depth = 210 ft bgs
- Volume of contaminated soil = 10,064,496 yd^3
- Based on 1.5H:1V excavation side slopes, total excavation volume = 17,305,470 yd^3
- Based on 1.5H:1V excavation side slopes, volume of overburden soil = 7,240,974 yd^3
- Total volume of material to dispose = 10,064,496 yd^3
- Volume of overburden soil = 7,240,974 yd^3

Available to use as backfill

- Volume of on-site borrow source material needed for backfilling. = 10,064,496 yd^3

As indicated in the General Assumptions (Section D3.3.1) no blending is required for 216-U-10 soils to meet the ERDF acceptance criteria.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of Construction oversight = 19,746 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT on excavator = 2 excavators x 12,922 days
  (equal to excavation time) = 25,844 days
- RCT rate = $448/day (see assumptions)
- Duration of RCT decontamination = 9,150 days
  (equal to contaminated soil excavation time)
- RCT decontamination crew rate = $1,792/day ($56/hour/RCT)

Fluor Hanford Sampling Crews and Sampling: Fluor Hanford will perform all sampling required. A bulking factor of 15% was applied to the contaminated soil volume to calculate the number of contaminated (LLW) samples. Sampling is calculated as follows:

Soil sampling (overburden soil, contaminated soil, and certification samples)

- Overburden samples = 6 samples (see assumptions)
- Contaminated (LLW) samples = 10,064,496 yd^3 + 15% x 1 sample/845 yd^3
  = 13,698 samples
- Site certification samples = 3,143,529 ft^2 x 1 sample/6,264 ft^2
  = 502 samples
- Offsite QC samples = (6 + 13,698 + 502) x 5%
  = 710 samples
- Soil/sediment sampling duration = 12,922 days (equal to excavation time)
- Sample crew (sampler 50% & RCT) = $672/day (see assumptions)
- Certification sample duration = 502 samples x 1 hours/3 samples
  = 167.3 hours
  = 21 days

Sample Crew (sampler & RCT) = $896/day (see assumptions).

Air Sampling

- Duration of Air Sampling = 12,922 days (equal to excavation time)
- Sampling crew (sampler & RCT) = $896/day (see assumptions)

- Number of air samples (1/day) = 12,922 samples.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions, the cost for transportation and disposal of contaminated material at the ERDF is $1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. The number of containers for disposal is calculated as follows:

- Total volume to dispose at ERDF = 10,064,496 yd^3 (see Site Description)
- Number of containers = 10,064,496 yd^3 x 1 container/11 yd^3
  = 914,955 containers.

Mobilization, Demobilization, and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating costs of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - Two bulldozers and two operators
  - Two front-end loaders and two operators
  - One water truck and one operator
  - Four laborers
  - One office trailer
  - One storage trailer.
- On-site borrow source
  - Two hydraulic excavators and two operators
  - Two front-end loaders and two operators
  - Ten dump trucks and ten drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hours/day x $37/hour = $592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction survey is based on the following:

Area of construction survey = area of excavation + 20% = 1,773 ft x 1,773 ft + 20% = 86.6 acres. The cost for a single survey equals $1,748/acre. The cost for two surveys equals $3,496/acre.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

Length of temporary fence = 2 x (width + length) + 20% = 2 x (1,773 ft + 1,773 ft) + 20% = 8,510 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = (24 ft x 1,500 ft) + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost = \$7.36/yd^2 (cost when placed at 6").

Decontamination Pad: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], polyvinyl chloride (PVC) pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2ft x 5ft x 30ft) + (2ft x 17ft x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20ft x 30ft) + (2ft x 8ft overlap x 30ft) + 10%
  = 1,188 ft^2
- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed (during excavation of contaminated soil = 9,150 days).

- Decontamination water = 1,000 gal/month x 9,150 days / 21 days/month
  = 435,714 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 9,150 days
- Daily rate for four laborers = \$1,184/day (\$37/hour/laborer).

Due to the duration of the project, the decontamination pad will be replaced once every 36 months.

Excavation: Activities performed under excavation include excavation of overburden soil, contaminated soil, and dust suppression. These activities are described below.

Overburden soil will be excavated using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing noncontaminated soil and placing it on the ground next to the excavation. A loader then will be used to move the soil to a nearby stock pile. The excavation of noncontaminated soil is expected to proceed at a rate of 120 yd^3 per hour per excavator. Working 8 hours/day, it is expected that 1,920 yd^3/day of overburden soil can be removed from the site. Labor for overburden excavation consists of one equipment operator for both hydraulic excavators and the front-end loader. The stock pile for the overburden soil is expected to be close enough to the excavation to allow the loader to meet or exceed the production rate of the excavator.

- Volume of overburden soil = 7,240,974 yd^3 (see Site Description)
- Days to excavate overburden soil = 7,240,974 yd^3 / 1,920 yd^3/day
  = 3,772 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator will be able to excavate the contaminated material and load it directly into the disposal containers. It is estimated that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to ERDF daily (as indicated in the general assumptions no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3 per day. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 10,064,496 yd^3 (see Site Description)
- Days to excavate contaminated soil = 10,064,496 yd^3 / 1,100 yd^3/day
  = 9,150 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Note: It is assumed that haul roads can be constructed into the cut backs during excavation to allow truck access to the excavation areas.

Dust suppression is required for the duration of the excavation process to minimize the generation of on site fugitive dust. A water truck will be rented for the duration of the excavation process. Cost for dust suppression is based on the following:

- Duration of excavation activities = 3,772 days + 9,150 days
  = 12,922 days
- Labor (water truck driver) = \$296/day + truck rental.

Site Restoration: Site restoration will consist of backfilling the excavation area with available overburden material and material obtained from the on-site borrow source. Site restoration activities also include planting vegetation following backfilling and using a water truck for dust suppression during backfilling operations. The rate of backfilling overburden and on-site borrow source materials varies. The following paragraphs describe the activities and labor required for site restoration activities.

Backfilling of overburden soil will be performed using two front-end loaders and two bulldozers. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour (for each loader and dozer). Operating two loaders and two dozers for 8 hours/day, the production rate is 2,960 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 7,240,974 yd^3 (see Site Description)
- Days to backfill overburden soil = 7,240,974 yd^3 / 2,960 yd^3/day
  = 2,447 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Backfilling with on-site borrow source material will be performed using two hydraulic excavators at the on-site borrow source, two front-end loaders at the on-site borrow source, ten trucks to transport the on-site borrow source material to the site, two front-end loaders on site, and two bulldozer on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (320 yd^3/hour or 2,560 yd^3/day). The cost associated with on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 10,064,496 yd^3 (see Site Description)
- Days to backfill on-site borrow source material = 10,064,496 yd^3 / 2,560 yd^3/day
  = 3,932 days
- On-site borrow source labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.
- On site labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.
- Labor (each truck) = \$37/hour x 8 hours/day
  = \$296/day + truck rental.

Dust suppression is required for the duration of the backfilling process to minimize the generation of on site dust. A water truck will be rented for the duration of the backfilling process. Cost for dust suppression is based on the following:

- Duration of backfill activities = 2,447 days + 3,932 days

	= 6,379 days
• Labor (water truck driver)	= \$296/day + truck rental.

Vegetation will be established following backfilling activities. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while backfilling is occurring, if feasible, and during demobilization. Vegetation costs are based on the following:

• Area to receive vegetation (disturbed area + 20%)	= (1,773 ft x 1,773 ft) + 20% = 419,137 yd^2
• Vegetation (includes lime, fertilizer, and seed)	= \$1.63/yd^2 (Means, 2004b)
• Days to vegetate area	= 419,137 yd^2 / 1,000 yd^2/day = 420 days.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

• Duration of contractor support	= 19,746 days
• Contractor support rate	= \$1,896/day (see assumptions)
• Prep. time for post construction documents	= 680 hours (assumed)
• Labor rate (post construction documents	= \$50/hour.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

D3.3.3 Representative Site 216-U-14 Ditch (Cost tables D-23 and D-24)

The site work was estimated to take 28.4 weeks (6.8 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 15 days (3 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.
- Excavate: 47 days (9.4 weeks)
- Restore site: 70 days (14 weeks) (Includes vegetation time)
- Demobilize: 10 days (2 weeks), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 142 days = 28.4 weeks = 6.8 months.

Site Description: The basis for the following information can be found on Table D-63.

• Area of contaminant mass	= 5,680 ft x 4 ft = 22,720 ft^2
• Depth of clean overburden soil	= 6 ft bgs
• Total excavation depth	= 15 ft bgs
• Volume of contaminated soil	= 7,573 yd^3
• Based on 1.5H:1V excavation side slopes, total excavation volume	= 84,235 yd^3
• Based on 1.5H:1V excavation side slopes, volume of overburden soil	= 76,661 yd^3
• Total volume of material to dispose	= 7,573 yd^3
• Volume of overburden soil Available to use as backfill	= 76,661 yd^3
• Volume of on-site borrow source material needed for backfilling.	= 7,573 yd^3

As indicated in the General Assumptions (Section D3.3.1) no blending is required for 216-U-14 soils to meet the ERDF acceptance criteria.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

• Duration of Construction oversight	= 142 days
• Construction oversight rate	= $1,720/day (see assumptions)
• Duration of RCT on excavator (equal to excavation time)	= 2 excavators x 47 days = 94 days
• RCT rate	= $448/day (see assumptions)
• Duration of RCT decontamination (equal to contaminated soil excavation time)	= 7 days
• RCT decontamination crew rate	= $1,792/day ($56/hour/RCT)

Fluor Hanford Sampling Crews and Sampling: Fluor Hanford will perform all sampling required. A bulking factor of 15% was applied to the contaminated soil volume to calculate the number of contaminated (LLW) samples. Sampling is calculated as follows:

<u>Soil sampling</u> (overburden soil, contaminated soil, and certification samples)

• Overburden samples	= 6 samples (see assumptions)
• Contaminated (LLW) samples	= 7,573 yd^3 + 15% x 1 sample/845 yd^3 = 11 samples
• Site certification samples	= 280,525 ft^2 x 1 sample/6,264 ft^2

	= 45 samples
• Offsite QC samples	= (6 + 11 + 45) x 5%
	= 4 samples
• Soil/sediment sampling duration	= 47 days (equal to excavation time)
• Sample crew (sampler 50% & RCT)	= $672/day (see assumptions)
• Certification sample duration	= 45 samples x 1 hours/3 samples
	= 15 hours
	= 2 days
• Sample Crew (sampler & RCT)	= $896/day (see assumptions).

Air Sampling

• Duration of Air Sampling	= 47 days (equal to excavation time)
• Sampling crew (sampler & RCT)	= $896/day (see assumptions)
• Number of air samples (1/day)	= 47 samples.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions, the cost for transportation and disposal of contaminated material at the ERDF is $1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. The number of containers for disposal is calculated as follows:

• Total volume to dispose at ERDF	= 7,573 yd^3 (see Site Description)
• Number of containers	= 7,573 yd^3 x 1 container/11 yd^3
	= 689 containers.

Mobilization, Demobilization, and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating costs of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - One bulldozer and one operator
  - One front-end loader and one operator
  - One water truck and one operator
  - Four laborers
  - One office trailer
  - One storage trailer.
- On-site borrow source

- One hydraulic excavator and one operator
- One front-end loader and one operator
- Five dump trucks and five drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hours/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction survey is based on the following:

Area of construction survey = area of excavation + 20% = 5,725 ft x 49 ft + 20% = 7.7 acres. The cost for a single survey equals \$1,748/acre. The cost for two surveys equals \$3,496/acre.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

Length of temporary fence = 2 x (width + length) + 20% = 2 x (5,725 ft + 49 ft) + 20% = 13,860 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = (24 ft x 1,500 ft) + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost = \$7.36/yd^2 (cost when placed at 6").

Decontamination Pad: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], PVC pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2ft x 5ft x 30ft) + (2ft x 17ft x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20ft x 30ft) + (2ft x 8ft overlap x 30ft) + 10%

= 1,188 ft^2

- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed (during excavation of contaminated soil = 7 days).

- Decontamination water = 1,000 gal/month x 7 days / 21 days/month
  = 333 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 7 days
- Daily rate for four laborers = \$1,184/day (\$37/hour/laborer).

Excavation: Activities performed under excavation include excavation of overburden soil, contaminated soil, and dust suppression. These activities are described below.

Overburden soil will be excavated using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing noncontaminated soil and placing it on the ground next to the excavation. A loader then will be used to move the soil to a nearby stock pile. The excavation of noncontaminated soil is expected to proceed at a rate of 120 yd^3 per hour per excavator. Working 8 hours/day, it is expected that 1,920 yd^3/day of overburden soil can be removed from the site. Labor for overburden excavation consists of one equipment operator for both hydraulic excavators and the front-end loader. The stock pile for the overburden soil is expected to be close enough to the excavation to allow the loader to meet or exceed the production rate of the excavator.

- Volume of overburden soil = 76,661 yd^3 (see Site Description)
- Days to excavate overburden soil = 76,661 yd^3 / 1,920 yd^3/day
  = 40 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator will be able to excavate the contaminated material and load it directly into the disposal containers. It is estimated that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to ERDF daily (as indicated in the general assumptions no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3 per day. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 7,573 yd^3 (see Site Description)
- Days to excavate contaminated soil = 7,573 yd^3 / 1,100 yd^3/day
  = 7 days

- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Note: It is assumed that haul roads can be constructed into the cut backs during excavation to allow truck access to the excavation areas.

Dust suppression is required for the duration of the excavation process to minimize the generation of on site fugitive dust. A water truck will be rented for the duration of the excavation process. Cost for dust suppression is based on the following:

- Duration of excavation activities = 40 days + 7 days
  = 47 days
- Labor (water truck driver) = \$296/day + truck rental.

Site Restoration: Site restoration will consist of backfilling the excavation area with available overburden material and material obtained from the on-site borrow source. Site restoration activities also include planting vegetation following backfilling and using a water truck for dust suppression during backfilling operations. The rate of backfilling overburden and the on-site borrow source materials varies. The following paragraphs describe the activities and labor required for site restoration activities.

Backfilling of overburden soil will be performed using two front-end loaders and two bulldozers. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour (for each loader and dozer). Operating two loaders and two dozers for 8 hours/day, the production rate is 2,960 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 76,661 yd^3 (see Site Description)
- Days to backfill overburden soil = 76,661 yd^3 / 2,960 yd^3/day
  = 26 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Backfilling with the on-site borrow source material will be performed using one hydraulic excavator at the on-site borrow source, one front-end loader at the on-site borrow source, five trucks to transport the on-site borrow source material to the site, one front-end loader on site, and one bulldozer on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (160 yd^3/hour or 1,280 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 7,573 yd^3 (see Site Description)
- Days to backfill on-site borrow = 7,573 yd^3 / 1,280 yd^3/day

source material	= 6 days
• On-site borrow source labor (each machine)	= \$37/hour x 8 hours/day = \$296/day + equipment rental.
• On site labor (each machine)	= \$37/hour x 8 hours/day = \$296/day + equipment rental.
• Labor (each truck)	= \$37/hour x 8 hours/day = \$296/day + truck rental.

Dust suppression is required for the duration of the backfilling process to minimize the generation of on site dust. A water truck will be rented for the duration of the backfilling process. Cost for dust suppression is based on the following:

• Duration of backfill activities	= 26 days + 6 days = 32 days
• Labor (water truck driver)	= \$296/day + truck rental.

Vegetation will be established following backfilling activities. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while backfilling is occurring, if feasible, and during demobilization. Vegetation costs are based on the following:

• Area to receive vegetation (disturbed area + 20%)	= (5,725 ft x 49 ft) + 20% = 37,403 yd^2
• Vegetation (includes lime, fertilizer, and seed)	= \$1.63/yd^2 (Means, 2004b)
• Days to vegetate area	= 37,403 yd^2 / 1,000 yd^2/day = 38 days.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

• Duration of contractor support	= 142 days
• Contractor support rate	= \$1,896/day (see assumptions)
• Prep. time for post construction documents	= 680 hours (assumed)
• Labor rate (post construction documents	= \$50/hour.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

D3.3.4 Representative Site 216-Z-11 Ditch (Cost tables D-25 and D-26)

This representative site is a group site containing sites 216-Z-11, 216-Z-1D, 216-Z-19, UPR-200-W-110, and 216-Z-20.

The site work was estimated to take 45.8 weeks (10.9 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 15 days (3 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.
- Excavate: 97 days (19.4 weeks)
- Restore site: 107 days (21.4 weeks)
- Demobilize: 10 days (2 weeks), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 229 days = 45.8 weeks = 10.9 months.

Site Description: The basis for the following information can be found on Table D-63.

• Area of contaminant mass	= (2,765 ft x 24 ft) + (1,635 ft x 4 ft) = 72,900 ft^2
• Depth of clean overburden soil	= 2 ft bgs
• Total excavation depth	= 15 ft bgs
• Volume of contaminated soil	= 35,100 yd^3
• Based on 1.5H:1V excavation side slopes, total excavation volume	= 96,975 yd^3
• Based on 1.5H:1V excavation side slopes, volume of overburden soil	= 61,875 yd^3
• Total volume of material to dispose	= 35,100 yd^3
• Total volume of TRU waste	= ((8 ft - 7 ft) x 72,900 ft^2) / 27 ft^3/yd^3 = 2,700 yd^3
• Total volume to ERDF	= 35,100 yd^3 – 2,700 yd^3 = 32,400 yd^3
• Volume of overburden soil Available to use as backfill	= 61,875 yd^3
• Volume material needed for backfilling.	= 35,100 yd^3

As indicated in the General Assumptions (Section D3.3.1) the soil that would require blending for disposal at the ERDF must be sent to WIPP. Therefore, for the 216-Z-11 soils being sent to ERDF for disposal, there is no blending required.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of Construction oversight = 229 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT on excavator = 2 excavators x 97 days
  (equal to excavation time) = 194 days
- RCT rate = $448/day (see assumptions)
- Duration of RCT decontamination = 64 days
  (equal to contaminated soil excavation time)
- RCT decontamination crew rate = $1,792/day ($56/hour/RCT)

It is anticipated that representative site 216-Z-11 will have TRU levels of contamination. Therefore, additional RCTs, an RCT supervisor, and a radiological engineer will be required during excavation. The additional Fluor Hanford oversight is calculated as follows:

- Duration of additional RCT, RCT Supervisor and radiological engineer = 97 days (equal excavation time)
- RCT Supervisor rate = $72.61/hour = $580.88/day
- Radiological engineer rate = $62.78/hour = $502.24/day

Fluor Hanford Sampling Crews and Sampling: Fluor Hanford will perform all sampling required. A bulking factor of 15% was applied to the contaminated soil volume to calculate the number of contaminated (LLW) samples. Sampling is calculated as follows:

<u>Soil sampling</u> (overburden soil, contaminated soil, and certification samples)

- Overburden samples = 6 samples (see assumptions)
- Contaminated (LLW) samples = 35,100 yd^3 + 15% x 1 sample/845 yd^3
  = 48 samples
- Site certification samples = 276,210 ft^2 x 1 sample/6,264 ft^2
  = 44 samples
- Offsite QC samples = (6 + 48 + 44) x 5%
  = 5 samples
- Soil/sediment sampling duration = 97 days (equal to excavation time)
- Sample crew (sampler 50% & RCT) = $672/day (see assumptions)

- Certification sample duration = 44 samples x 1 hours/3 samples
  = 15 hours
  = 2 days
- Sample Crew (sampler & RCT) = \$896/day (see assumptions).

Air Sampling

- Duration of Air Sampling = 97 days (equal to excavation time)
- Sampling crew (sampler & RCT) = \$896/day (see assumptions)
- Number of air samples (1/day) = 97 samples.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions, the cost for transportation and disposal of contaminated material at the ERDF is \$1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. The number of containers for disposal is calculated as follows:

- Total volume disposed at ERDF = 32,400 yd^3 (see Site Description)
- Number of containers = 32,400 yd^3 x 1 container/11 yd^3
  = 2,946 containers

TRU waste encountered at 216-Z-11 will be loaded into containers, hauled to the Waste Receipt and Processing Facility (WRAP), and temporarily stored in a hopper. The transportation rate of hauling TRU waste to the WRAP is based on 20 containers being sent to WRAP on a daily basis. With 11 yd^3 of material per container, 220 yd^3 of TRU material will be sent to WRAP daily. From the hopper, the TRU waste will be placed into galvanized 55-gallon drums with passive vents installed in the drum lid. These drums will be placed in a spill pallet capable of holding 55–gallon containers. Four laborers will be present to assist in the loading of the drums. When all loading has been completed, the drums will be hauled to the T-Plant Canyon for storage. Final disposal of the drums will be at the WIPP in New Mexico.

- Volume of TRU waste to dispose = 2,700 yd^3 (see Site Description)
- Days to haul TRU waste to WRAP = 2,700 yd^3 / 220 yd^3/day
  = 13 days
- Number of 55-gallon drums = 2,700 yd^3 x 27 ft^3/yd^3 x 7.48 gal/ft^3
  = 545,292 gal / 50 gal/drum
  = 10,906 drums
- Per 55-gallon drum cost (delivered) = \$175/drum x 10,906 drums = \$1,908,550
- Drum loading rate = 100 drums/day (assumed)
- Duration of drum loading crew = 10,906 drums / 100 drums/day
  = 109 days
- Certify and load drums of TRU waste = \$5,000 per drum.

Although the WIPP programmatic cost for Hanford waste is $31,366/m^3$, this cost has not been included in the cost estimate.

Mobilization, Demobilization, and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating costs of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - One bulldozer and one operator
  - One front-end loader and one operator
  - One water truck and one operator
  - Four laborers
  - One office trailer
  - One storage trailer
- On-site borrow source
  - One hydraulic excavator and one operator
  - One front-end loader and one operator
  - Five dump trucks and five drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hours/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction survey is based on the following:

Area of construction survey = area of excavation + 20% = (2,810 ft x 69 ft) + (1,680 ft x 49 ft) = 276,210 ft^2 + 20% = 7.6 acres. The cost for a single survey equals \$1,748/acre. The cost for two surveys equals \$3,496/acre.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

Length of temporary fence = 2 x (width + length) + 20% = (2 x (2,810 ft + 69 ft)) + (2 x (1,680 ft + 49 ft)) + 20% = 11,060 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft

- Width of haul road = 24 ft
- Gravel = (24 ft x 1,500 ft) + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost = $7.36/$yd^2$ (cost when placed at 6").

Decontamination Pad: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], PVC pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2ft x 5ft x 30ft) + (2ft x 17ft x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20ft x 30ft) + (2ft x 8ft overlap x 30ft) + 10%
  = 1,188 ft^2
- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed (during excavation of contaminated soil = 64 days).

- Decontamination water = 1,000 gal/month x 64 days / 21 days/month
  = 3,048 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 64 days
- Daily rate for four laborers = $1,184/day ($37/hour/laborer).

Excavation: Activities performed under excavation include excavation of overburden soil, contaminated soil, and dust suppression. These activities are described below.

Overburden soil will be excavated using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing noncontaminated soil and placing it on the ground next to the excavation. A loader then will be used to move the soil to a nearby stock pile. The excavation of noncontaminated soil is expected to proceed at a rate of 120 yd^3 per hour per excavator. Working 8 hours/day, it is expected that 1,920 yd^3/day of overburden soil can be removed from the site. Labor for overburden excavation consists of one equipment operator for both hydraulic excavators and the front-end loader. The stock pile for the overburden soil is expected to be close enough to the excavation to allow the loader to meet or exceed the production rate of the excavator.

- Volume of overburden soil = 61,875 yd^3 (see Site Description)
- Days to excavate overburden soil = 61,875 yd^3 / 1,920 yd^3/day
  = 33 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator will be able to excavate the contaminated material and load it directly into the disposal containers. Since 216-Z-11 is expected to contain TRU waste, it is expected that the excavation rate will decrease by half. Therefore, it is estimated that 50 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, 550 yd^3 of material will be sent to ERDF daily (as indicated in the general assumptions no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 550 yd^3 per day. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 35,100 yd^3 (see Site Description)
- Days to excavate contaminated soil = 35,100 yd^3 / 550 yd^3/day
  = 64 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Note: It is assumed that haul roads can be constructed into the cut backs during excavation to allow truck access to the excavation areas.

Dust suppression is required for the duration of the excavation process to minimize the generation of on site fugitive dust. A water truck will be rented for the duration of the excavation process. Cost for dust suppression is based on the following:

- Duration of excavation activities = 33 days + 64 days
  = 97 days
- Labor (water truck driver) = \$296/day + truck rental.

Site Restoration: Site restoration will consist of backfilling the excavation area with available overburden material and material obtained from the on-site borrow source. Site restoration activities also include planting vegetation following backfilling and using a water truck for dust suppression during backfilling operations. The rate of backfilling overburden and the on-site borrow source materials varies. The following paragraphs describe the activities and labor required for site restoration activities.

Backfilling of overburden soil will be performed using one front-end loader and one bulldozer. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour, or

1,480 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

• Volume of overburden to backfill	= 61,875 yd^3 (see Site Description)
• Days to backfill overburden soil	= 61,875 yd^3 / 1,480 yd^3/day
	= 42 days
• Labor (each machine)	= \$37/hour x 8 hours/day
	= \$296/day + equipment rental.

Backfilling with the on-site borrow source material will be performed using one hydraulic excavator at the on-site borrow source, one front-end loader at the on-site borrow source, five trucks to transport the on-site borrow source material to the site, one front-end loader on site, and one bulldozer on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on five trucks carrying 16 yd^3 each, making two trips an hour (160 yd^3/hour or 1,280 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

• On-site borrow source material backfill volume	= 35,100 yd^3 (see Site Description)
• Days to backfill on-site borrow source material	= 35,100 yd^3 / 1,280 yd^3/day = 28 days
• On-site borrow source labor (each machine)	= \$37/hour x 8 hours/day = \$296/day + equipment rental.
• On site labor (each machine)	= \$37/hour x 8 hours/day = \$296/day + equipment rental.
• Labor (each truck)	= \$37/hour x 8 hours/day = \$296/day + truck rental.

Dust suppression is required for the duration of the backfilling process to minimize the generation of on site dust. A water truck will be rented for the duration of the backfilling process. Cost for dust suppression is based on the following:

• Duration of backfill activities	= 42 days + 28 days
	= 70 days
• Labor (water truck driver)	= \$296/day + truck rental.

Vegetation will be established following backfilling activities. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while backfilling is occurring, if feasible, and during demobilization. Vegetation costs are based on the following:

• Area to receive vegetation (disturbed area + 20%)	= (276,210 ft^2) + 20% = 36,828 yd^2

- Vegetation (includes lime, fertilizer, and seed) = \$1.63/yd^2 (Means, 2004b)
- Days to vegetate area = 36,828 yd^2 / 1,000 yd^2/day = 37 days.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

- Duration of contractor support = 229 days
- Contractor support rate = \$1,896/day (see assumptions)
- Prep time for post construction documents = 680 hours (assumed)
- Labor rate (post construction documents = \$50/hour.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

D3.3.5 Representative Site 216-A-25 Gable Mountain Pond (Cost tables D-27 and D-28)

The site work was estimated to take 406 weeks (96.7 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 15 days (3 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.

- Excavate: 1,067 days (213.4 weeks)

- Restore site: 938 days (187.6 weeks)

- Demobilize: 10 days (2 weeks), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 2,030 days = 406 weeks = 96.7 months.

Site Description: The basis for the following information can be found on Table D-63.

- Area of contaminant mass = 3,800 ft x 700 ft = 2,660,000 ft^2
- Depth of clean overburden soil = 8 ft bgs
- Total excavation depth = 15 ft bgs
- Volume of contaminated soil = 689,630 yd^3
- Based on 1.5H:1V excavation side = 1,534,240 yd^3

slopes, total excavation volume

- Based on 1.5H:1V excavation side slopes, volume of overburden soil = 844,610 yd^3
- Total volume of material to dispose = 689,630 yd^3
- Volume of overburden soil Available to use as backfill = 844,610 yd^3
- Volume of on-site borrow source material needed for backfilling. = 689,630 yd^3

As indicated in the General Assumptions (Section D3.3.1) no blending is required for 216-A-25 soils to meet the ERDF acceptance criteria.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of Construction oversight = 2,030 days
- Construction oversight rate = \$1,720/day (see assumptions)
- Duration of RCT on excavator (equal to excavation time) = 2 excavators x 1,067 days = 2,134 days
- RCT rate = \$448/day (see assumptions)
- Duration of RCT decontamination = 627 days (equal to contaminated soil excavation time)
- RCT decontamination crew rate = \$1,792/day (\$56/hour/RCT)

Fluor Hanford Sampling Crews and Sampling: Fluor Hanford will perform all sampling required. A bulking factor of 15% was applied to the contaminated soil volume to calculate the number of contaminated (LLW) samples. Sampling is calculated as follows:

<u>Soil sampling</u> (overburden soil, contaminated soil, and certification samples)

- Overburden samples = 6 samples (see assumptions)
- Contaminated (LLW) samples = 689,630 yd^3 + 15% x 1 sample/845 yd^3 = 939 samples
- Site certification samples = 2,864,525 ft^2 x 1 sample/6,264 ft^2 = 458 samples
- Offsite QC samples = (6 + 939 + 458) x 5% = 70 samples
- Soil/sediment sampling duration = 1,067 days (equal to excavation time)
- Sample crew (sampler 50% & RCT) = \$672/day (see assumptions)
- Certification sample duration = 458 samples x 1 hours/3 samples

= 153 hours

= 19 days

- Sample Crew (sampler & RCT) = \$896/day (see assumptions).

Air Sampling

- Duration of Air Sampling = 1,067 days (equal to excavation time)
- Sampling crew (sampler & RCT) = \$896/day (see assumptions)
- Number of air samples (1/day) = 1,067 samples.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions, the cost for transportation and disposal of contaminated material at the ERDF is \$1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. The number of containers for disposal is calculated as follows:

- Total volume to dispose at ERDF = 689,630 yd^3 (see Site Description)
- Number of containers = 689,630 yd^3 x 1 container/11 yd^3

= 62,694 containers.

Mobilization, Demobilization, and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating costs of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - Two bulldozers and two operators
  - Two front-end loaders and two operators
  - One water truck and one operator
  - Four laborers
  - One office trailer
  - One storage trailer.
- On-site borrow source
  - Two hydraulic excavators and two operators
  - Two front-end loaders and two operators
  - Ten dump trucks and ten drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hours/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction survey is based on the following:

> Area of construction survey = area of excavation + 20% = (3,845 ft x 745 ft) + 20% = 78.9 acres. The cost for a single survey equals $1,748/acre. The cost for two surveys equals $3,496/acre.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

> Length of temporary fence = 2 x (width + length) + 20% = 2 x (3,845 ft + 745 ft) + 20% = 11,016 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = (24 ft x 1,500 ft) + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost = $7.36/yd^2 (cost when placed at 6").

Decontamination Pad: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], PVC pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2ft x 5ft x 30ft) + (2ft x 17ft x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20ft x 30ft) + (2ft x 8ft overlap x 30ft) + 10%
  = 1,188 ft^2
- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed (during excavation of contaminated soil = 627 days).

- Decontamination water = 1,000 gal/month x 627 days / 21 days/month

= 29,857 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 627 days
- Daily rate for four laborers = \$1,184/day (\$37/hour/laborer).

Due to the duration of the project, the decontamination pad will be replaced once every 36 months.

Excavation: Activities performed under excavation include excavation of overburden soil, contaminated soil, and dust suppression. These activities are described below.

Overburden soil will be excavated using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing noncontaminated soil and placing it on the ground next to the excavation. A loader then will be used to move the soil to a nearby stock pile. The excavation of noncontaminated soil is expected to proceed at a rate of 120 yd^3 per hour per excavator. Working 8 hours/day, it is expected that 1,920 yd^3/day of overburden soil can be removed from the site. Labor for overburden excavation consists of one equipment operator for both hydraulic excavators and the front-end loader. The stock pile for the overburden soil is expected to be close enough to the excavation to allow the loader to meet or exceed the production rate of the excavator.

- Volume of overburden soil = 844,610 yd^3 (see Site Description)
- Days to excavate overburden soil = 844,610 yd^3 / 1,920 yd^3/day
  = 440 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator will be able to excavate the contaminated material and load it directly into the disposal containers. It is estimated that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to ERDF daily (as indicated in the general assumptions no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3 per day. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 689,630 yd^3 (see Site Description)
- Days to excavate contaminated soil = 689,630 yd^3 / 1,100 yd^3/day
  = 627 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Note: It is assumed that haul roads can be constructed into the cut backs during excavation to allow truck access to the excavation areas.

Dust suppression is required for the duration of the excavation process to minimize the generation of on site fugitive dust. A water truck will be rented for the duration of the excavation process. Cost for dust suppression is based on the following:

- Duration of excavation activities = 440 days + 627 days
  = 1,067 days
- Labor (water truck driver) = \$296/day + truck rental.

Site Restoration: Site restoration will consist of backfilling the excavation area with available overburden material and material obtained from the on-site borrow source. Site restoration activities also include planting vegetation following backfilling and using a water truck for dust suppression during backfilling operations. The rate of backfilling overburden and the on-site borrow source materials varies. The following paragraphs describe the activities and labor required for site restoration activities.

Backfilling of overburden soil will be performed using two front-end loaders and two bulldozers. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour (for each loader and dozer). Operating two loaders and two dozers for 8 hours/day, the production rate is 2,960 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 844,610 yd^3 (see Site Description)
- Days to backfill overburden soil = 844,610 yd^3 / 2,960 yd^3/day
  = 286 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Backfilling with the on-site borrow source material will be performed using two hydraulic excavators at the on-site borrow source, two front-end loaders at the on-site borrow source, ten trucks to transport the on-site borrow source material to the site, two front-end loaders on site, and two bulldozer on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (320 yd^3/hour or 2,560 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 689,630 yd^3 (see Site Description)
- Days to backfill on-site borrow source material = 689,630 yd^3 / 2,560 yd^3/day
  = 270 days
- On-site borrow source labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

- On site labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.
- Labor (each truck) = \$37/hour x 8 hours/day
  = \$296/day + truck rental.

Dust suppression is required for the duration of the backfilling process to minimize the generation of on site dust. A water truck will be rented for the duration of the backfilling process. Cost for dust suppression is based on the following:

- Duration of backfill activities = 286 days + 270 days
  = 556 days
- Labor (water truck driver) = \$296/day + truck rental.

Vegetation will be established following backfilling activities. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while backfilling is occurring, if feasible, and during demobilization. Vegetation costs are based on the following:

- Area to receive vegetation (disturbed area + 20%) = (3,845 ft x 745 ft) + 20%
  = 381,936 yd^2
- Vegetation (includes lime, fertilizer, and seed) = \$1.63/yd^2 (Means, 2004b)
- Days to vegetate area = 381,936 yd^2 / 1,000 yd^2/day
  = 382 days.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

- Duration of contractor support = 2,030 days
- Contractor support rate = \$1,896/day (see assumptions)
- Prep. time for post construction documents = 680 hours (assumed)
- Labor rate (post construction documents = \$50/hour.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

D3.3.6 Representative Site 216-T-26 Crib (Cost tables D-29 and D-30)

The site work was estimated to take 267.6 weeks (63.7 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 15 days (3 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.
- Excavate: 755 days (151 weeks)
- Restore site: 558 days (111.6 weeks)
- Demobilize: 10 days (2 weeks), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 1,338 days = 267.6 weeks = 63.7 months.

Site Description: The basis for the following information can be found on Table D-63.

- Area of contaminant mass = 30 ft x 30 ft = 900 ft^2
- Depth of clean overburden soil = 18 ft bgs
- Total excavation depth = 225 ft bgs
- Volume of contaminated soil = 6,900 yd^3
- Based on 1.5H:1V excavation side slopes, total excavation volume = 1,441,875 yd^3
- Based on 1.5H:1V excavation side slopes, volume of overburden soil = 1,434,975 yd^3
- Total volume of material to dispose = 6,900 yd^3
- Volume of overburden soil Available to use as backfill = 1,434,975 yd^3
- Volume of on-site borrow source material needed for backfilling. = 6,900 yd^3

As indicated in the General Assumptions (Section D3.3.1) no blending is required for 216-T-26 soils to meet the ERDF acceptance criteria.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of Construction oversight = 1,338 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT on excavator (equal to excavation time) = 2 excavators x 755 days = 1,510 days
- RCT rate = $448/day (see assumptions)
- Duration of RCT decontamination (equal to contaminated soil excavation time) = 7 days

- RCT decontamination crew rate = \$1,792/day (\$56/hour/RCT)

Fluor Hanford Sampling Crews and Sampling: Fluor Hanford will perform all sampling required. A bulking factor of 15% was applied to the contaminated soil volume to calculate the number of contaminated (LLW) samples. Sampling is calculated as follows:

Soil sampling (overburden soil, contaminated soil, and certification samples)

- Overburden samples = 6 samples (see assumptions)
- Contaminated (LLW) samples = 6,900 yd^3 + 15% x 1 sample/845 yd^3 = 10 samples
- Site certification samples = 497,025 ft^2 x 1 sample/6,264 ft^2 = 80 samples
- Offsite QC samples = (6 + 10 + 80) x 5% = 5 samples
- Soil/sediment sampling duration = 755 days (equal to excavation time)
- Sample crew (sampler 50% & RCT) = \$672/day (see assumptions)
- Certification sample duration = 80 samples x 1 hours/3 samples = 27 hours = 4 days
- Sample Crew (sampler & RCT) = \$896/day (see assumptions).

Air Sampling

- Duration of Air Sampling = 755 days (equal to excavation time)
- Sampling crew (sampler & RCT) = \$896/day (see assumptions)
- Number of air samples (1/day) = 755 samples.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions, the cost for transportation and disposal of contaminated material at the ERDF is \$1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. The number of containers for disposal is calculated as follows:

- Total volume to dispose at ERDF = 6,900 yd^3 (see Site Description)
- Number of containers = 6,900 yd^3 x 1 container/11 yd^3 = 628 containers.

Mobilization, Demobilization, and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating costs of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - Two bulldozers and two operators
  - Two front-end loaders and two operators
  - One water truck and one operator
  - Four laborers
  - One office trailer
  - One storage trailer.
- On-site borrow source
  - One hydraulic excavator and one operator
  - One front-end loader and one operator
  - Five dump trucks and five drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hours/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction survey is based on the following:

Area of construction survey = area of excavation + 20% = 705 ft x 705 ft + 20% = 13.7 acres. The cost for a single survey equals \$1,748/acre. The cost for two surveys equals \$3,496/acre.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

Length of temporary fence = 2 x (width + length) + 20% = 2 x (705 ft + 705 ft) + 20% = 3,384 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = (24 ft x 1,500 ft) + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost = \$7.36/yd^2 (cost when placed at 6").

Decontamination Pad: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], PVC pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2ft x 5ft x 30ft) + (2ft x 17ft x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20ft x 30ft) + (2ft x 8ft overlap x 30ft) + 10%
  = 1,188 ft^2
- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed (during excavation of contaminated soil = 7 days).

- Decontamination water = 1,000 gal/month x 7 days / 21 days/month
  = 333 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 7 days
- Daily rate for four laborers = \$1,184/day (\$37/hour/laborer).

Due to the duration of the project, the decontamination pad will be replaced once every 36 months.

Excavation: Activities performed under excavation include excavation of overburden soil, contaminated soil, and dust suppression. These activities are described below.

<u>Overburden soil</u> will be excavated using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing noncontaminated soil and placing it on the ground next to the excavation. A loader then will be used to move the soil to a nearby stock pile. The excavation of noncontaminated soil is expected to proceed at a rate of 120 yd^3 per hour per excavator. Working 8 hours/day, it is expected that 1,920 yd^3/day of overburden soil can be removed from the site. Labor for overburden excavation consists of one equipment operator for both hydraulic excavators and the front-end loader. The stock pile for the overburden soil is expected to be close enough to the excavation to allow the loader to meet or exceed the production rate of the excavator.

- Volume of overburden soil = 1,434,975 yd^3 (see Site Description)
- Days to excavate overburden soil = 1,434,975 yd^3 / 1,920 yd^3/day
  = 748 days

- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator will be able to excavate the contaminated material and load it directly into the disposal containers. It is estimated that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to ERDF daily (as indicated in the general assumptions no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3 per day. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 6,900 yd^3 (see Site Description)
- Days to excavate contaminated soil = 6,900 yd^3 / 1,100 yd^3/day
  = 7 days
- Labor (each machine) = \$37/hour x 8 hours/day
  = \$296/day + equipment rental.

Note: It is assumed that haul roads can be constructed into the cut backs during excavation to allow truck access to the excavation areas.

Dust suppression is required for the duration of the excavation process to minimize the generation of on site fugitive dust. A water truck will be rented for the duration of the excavation process. Cost for dust suppression is based on the following:

- Duration of excavation activities = 748 days + 7 days
  = 755 days
- Labor (water truck driver) = \$296/day + truck rental.

Site Restoration: Site restoration will consist of backfilling the excavation area with available overburden material and material obtained from the on-site borrow source. Site restoration activities also include planting vegetation following backfilling and using a water truck for dust suppression during backfilling operations. The rate of backfilling overburden and the on-site borrow source materials varies. The following paragraphs describe the activities and labor required for site restoration activities.

Backfilling of overburden soil will be performed using two front-end loaders and two bulldozers. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour (for each loader and dozer). Operating two loaders and two dozers for 8 hours/day, the production rate is 2,960 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 1,434,975 yd^3 (see Site Description)
- Days to backfill overburden soil = 1,434,975 yd^3 / 2,960 yd^3/day
  = 485 days

- Labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.

Backfilling with the on-site borrow source material will be performed using one hydraulic excavator at the on-site borrow source, one front-end loader at the on-site borrow source, five trucks to transport the on-site borrow source material to the site, one front-end loader on site, and one bulldozer on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (160 yd^3/hour or 1,280 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 6,900 yd^3 (see Site Description)
- Days to backfill on-site borrow source material = 6,900 yd^3 / 1,280 yd^3/day = 6 days
- On-site borrow source labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- On site labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- Labor (each truck) = \$37/hour x 8 hours/day = \$296/day + truck rental.

Dust suppression is required for the duration of the backfilling process to minimize the generation of on site dust. A water truck will be rented for the duration of the backfilling process. Cost for dust suppression is based on the following:

- Duration of backfill activities = 485 days + 6 days = 491 days
- Labor (water truck driver) = \$296/day + truck rental.

Vegetation will be established following backfilling activities. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while backfilling is occurring, if feasible, and during demobilization. Vegetation costs are based on the following:

- Area to receive vegetation (disturbed area + 20%) = (705 ft x 705 ft) + 20% = 66,270 yd^2
- Vegetation (includes lime, fertilizer, and seed) = \$1.63/yd^2 (Means, 2004b)
- Days to vegetate area = 66,270 yd^2 / 1,000 yd^2/day = 67 days.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

- Duration of contractor support = 1,338 days
- Contractor support rate = $1,896/day (see assumptions)
- Prep. time for post construction documents = 680 hours (assumed)
- Labor rate (post construction documents = $50/hour.

Annual Cost: No annual costs are associated with Alternative 3. No site monitoring is required because all of the contaminated waste will be removed.

D3.4 ALTERNATIVE 4 – CAPPING

D3.4.1 General Assumptions

The following general assumptions apply to Alternative 4:

- Representative site areas range from 900 ft^2 to 2,660,000 ft^2. Because of the difference, larger construction crews will be used for sites over 100,000 ft^2. Refer to site specific text for production rates.

- The contractor will perform all the site preparation, capping, decontamination, and restoration activities for this alternative. Personnel used to complete these tasks are support personnel, laborers, equipment operators, oilers, and truck drivers. The support personnel will consist of a superintendent, a site foreman, a site engineer, a site health and safety manager, and a timekeeper-clerk. This support crew will be on site from mobilization to demobilization. Using the wage rates discussed in Section D3.1, this crew has an hourly rate of $237 ($1,896/day). The number of laborers, equipment operators, oilers, and truck drivers are identified under the activities discussed in the following paragraphs.

- The contractor will provide a crew of 4 laborers for the duration of the project. These laborers will perform general activities including, but not limited to, decontamination, placing geotextile, and maintaining/fueling equipment.

- Fluor Hanford will provide contractor oversight, collect samples, and perform all radiation screening. Personnel used to perform contractor oversight include a project manager, health and safety manager (half time), a QA/QC representative and scheduler, and a RCT. This oversight crew will be used when ever the contractor is in operation. Using the wage rates discussed in Section D3.1, this crew has an hourly rate of $215 ($1,720/day).

- Fluor Hanford will provide a crew of four RCTs for decontamination activities. Using the wage rates discussed in Section D3.1, the crew has an hourly rate of $224 ($1,792/day).

- Fluor Hanford will provide a crew of one sample technician and one RCT to collect air samples during dynamic compaction and installation of the first cap layer at a rate of one composite air sample per day. Using the wage rates discussed in Section D3.1, the crew has an hourly rate of $112 ($896/day). The analytical cost for air samples is assumed to equal $1,000/sample and it is expected that sampling equipment will cost $500/day.

- Fencing for institutional controls, fencing maintenance, and monuments/signs are considered institutional costs and are not considered in this cost estimate.

- Periodic groundwater monitoring costs will be added to Table D-65 as indicated in Section D3.1.4.

- Dynamic compaction will be the only construction activity occurring prior to constructing the first cap layer. To construct the first cap layer, material will be placed on the outer edges of the site and pushed into place to avoid running equipment over the site without the first layer of cap material in place.

- Surface soil is not affected. Therefore, Level C, B, or A PPE is not needed for this alternative.

- The prices that make up the cost estimate were obtained from one of the following sources:

  – *ECHOS Environmental Remediation Cost Data – Unit Price*, 10th Annual Edition (Means, 2004a).

  – *Site Work and Landscape Cost Data*, 23rd Annual Edition (Means, 2004b).

  – Experience on similar projects.

D3.4.2 Representative Site 216-U-10 Pond (Cost tables D-31 through D-34)

The site work was estimated to take 75 weeks (17.8 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and evaluating landfill limits.

- Prepare site: 76 days (15.2 weeks)

- Capping: 244 days (48.8 weeks)

- Revegetation: 40 day (8 weeks)
- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

Total construction duration = 375 days = 75 weeks = 17.8 months.

Site Description: The following information can be found on Table D-63.

- Area of contaminated mass = 1,143 ft x 1,143 ft = 1,306,449 ft^2
- Area of cap with 20-ft overrun = [1,143 ft + (40 ft)] x [1,143 ft + (40 ft)] = 1,183 ft x 1,183 ft = 1,399,489 ft^2
- Slope of rise and run of cap = 2H:1V (2 horizontal to 1 vertical)
- Length of rise = 40 in. / (12 in/ft) x 2 x 2 = 13.33 ft
- Length of run = 108 in. / (12 in/ft) x 2 x 2 = 36 ft
- Cap area total length = 1,183 ft + 13.33 ft + 36 ft = 1,232.33 ft
- Cap area total width = 1,183 ft + 13.33 ft + 36 ft = 1,232.33 ft
- Area of cap footprint = 1,232.33 ft x 1,232.33 ft = 1,518,645 ft^2 = 34.86 acres.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of construction oversight = 375 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT decontamination Crew = 1 day
- RCT crew rate = $1,792/day (see assumptions).

Fluor Hanford Sampling: As indicated in the general assumptions, Fluor Hanford will provide an air sampling crew to collect air samples during dynamic compaction and placement of the first cap layer. Samples will be collected at a rate of one sample per day of activity. The cost for sampling is based on the following:

- Duration of dynamic compaction = 76 days (see below)
- Duration to install first cap layer = 73 days (see below)
- Total number of air samples = 149 samples (1 sample/day)
- Sampling crew (sample and RCT) = $896/day (see assumptions).

Mobilization/Demobilization and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating cost of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Two hydraulic excavators and two operators (on-site borrow source)
- Two front-end loaders and two operators (on-site borrow source)
- Two bulldozers and two operators (on site)
- Two front-end loaders and two operators (on site)
- One grader and one operator (on site)
- One water truck and one driver
- Ten dump trucks and ten drivers
- Two vibratory rollers and two operators (on site)
- One office trailer
- One storage trailer
- Four laborers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hour/day x $37/hour = $592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and following the installation of identified cap layers (7 layers). The cost for a single construction survey is based on the following:

Area of construction survey = area of cap footprint + 20% = 1,518,645 ft^2 + 20% = 1,822,374 ft^2 = 41.84 acre.

Total surveys performed = 8.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Haul Road Construction = $7.36/$yd^2$.

Decontamination Pad: A decontamination pad will be constructed to clean the dynamic compaction equipment. It is assumed that the dynamic compaction equipment can be decontaminated for reuse and can be decontaminated in one day. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting (60 mil LLDPE), PVC pipe, and a sump with a pump and hoses. Based on the Alternative 3 assumption for decontamination pad water use (1,000 gallons per month), 50 gallons of water are required for one day of decontamination activity. Therefore, it is assumed that a temporary water source can be obtained for decontamination activities and large storage tanks will not be required. It is also assumed that the sump can adequately store the rinse water prior to using for dust suppression on contaminated sites. Decontamination pad components are as follows:

• Pad area	= 20 ft x 30 ft
	= 600 ft^2
• Timber grates (2 in. x 4 in.)	= (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
	= 402 linear feet
	= 0.402m board ft
• Plastic sheeting	= (20 ft x 30 ft) + (2 x 8 ft overlap) + 10%
	= 1,188 ft^2
• 3 in. PVC pipe	= 5 linear ft.

All equipment rented for the decontamination pad will be rented for the duration of the RA activities, in the event that the decontamination pad is needed. It is assumed that equipment can be decontaminated for reuse.

The decontamination pad will be staffed for one day to decontaminate the dynamic compaction equipment following site stabilization. The decontamination crew will consist of four laborers. This crew will construct the decontamination pad, provide decontamination services, and remove the decontamination pad during demobilization activities (labor provided under miscellaneous costs).

Site Preparation: Costs associated with site preparation are capital costs. Before installing the cap system, the site surface must be prepared. Surface preparation includes stabilization of the cap area using dynamic compaction. The FS indicates a need to ensure compaction of soils at depth (i.e., compaction of soil deeper than 2 ft). To avoid the time delay associated with surcharging the area, a crane will be used to drop a large weight over the cap area. Dynamic compaction was selected during the FS process as a baseline technology and for costing purposes; other compaction processes may be selected during the design process. For cap areas greater than 1,000,000 ft^2, four dynamic compactors will be mobilized to the site. For cap areas greater than 100,000 ft^2 but less than 1,000,000 ft^2, two dynamic compactors will be mobilized to the site. Lastly, for cap areas less than 100,000 ft^2, one dynamic compactor will be mobilized to the site. The cost of site preparation is calculated as follows:

• Footprint of cap	= 1,518,645 ft^2
• Production rate per compactor	= 5,000 ft^2/day (assumed)
• Four compactors	= 20,000 ft^2/day
• Time required for dynamic compaction	= 76 days
• Days air sampling support required	= 76 days.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 77 days.

Installation of Cap System: Representative Site 216-U-10 pond requires a Modified RCRA Subtitle C Barrier. The Modified RCRA Subtitle C Barrier design consists of, from bottom to top, the following layers:

- Graded fill layer (40 in. thick)
- Asphalt base course (4 in. thick)
- Low-permeability asphalt layer (6 in. thick)
- Lateral drainage layer (6 in. thick)
- Gravel filter layer (6 in. thick)
- Sand filter layer (6 in. thick)
- Non-woven geotextile
- Compacted silt loam (20 in. thick)
- Silt loam topsoil with pea gravel admixture (20 in. thick)
- Vegetation.

Total cap thickness = 108 in = 9 ft.

The volume of material for these layers is calculated using the area of the site and adding a 20-ft overrun in each direction to ensure complete site coverage. Assume 2H:1V side slopes. Refer to Table D-63 for site dimensions. These areas and volumes will be used for the cost estimate:

- Area of the site = 1,306,449 ft^2
- Total area of the cap (area of site + 20 ft overrun) = 1,399,489 ft^2
- Footprint of capped area = 1,518,645 ft^2
- Graded fill (40 in. sloped at 2%) = 185,470 yd^3
- Asphalt base course (4 in.) = 165,107 yd^2
- Low-permeability asphalt (6 in.) = 165,107 yd^2
- Lateral drainage layer (6 in.) = 27,323 yd^3
- Gravel filter layer (6 in.) = 27,233 yd^3
- Sand filter layer (6 in.) = 26,573 yd^3
- Nonwoven geotextile = 1,434,958 ft^2
  = 159,440 yd^2
- Compacted silt loam (20 in.) = 86,876 yd^3
- Silt loam with pea gravel (20 in.) = 87,856 yd^3
- 10% of mix is pea gravel = 8,786 yd^3
- Graded fill for cap berm = 5,209 yd^3.

The production rate assumes that the haul rate for the cap materials is 160 yd^3/hour or 1,280 yd^3/day (if the cap area is less than 1,000,000 ft^2) and 320 yd^3/hour or 2,560 yd^3/day (if the cap area is greater than 1,000,000 ft^2). The rate at which the cap materials can be placed and graded is assumed equal to the rate material is delivered. Additionally, it is assumed that the pea gravel will be mixed with the silt loam in place. A bulldozer with a tiller attachment will be used to spread both the silt loam and pea gravel. While placing the pea gravel, the tiller attachment will blend the two materials.

Paving rates are based on 4,545 yd^2/day (areas less than 100,000 ft^2) and 9,090 yd^2/day (area greater than 100,000 ft^2) for the four inch sub-grade layer. For the six inch layer, paving rates equal 2,452 yd^2/day (areas less than 100,000 ft^2) and 4,904 yd^2/day (areas greater than 100,000 ft^2).

Due to the size and shape of the cap berm, the production rate is assumed to be ½ the production rates used for placing soils over large areas. The production rates for the cap berm equal 80 yd^3/hour or 640 yd^3/day (for sites less than 1,000,000 ft^2) and 160 yd^3/hour or 1,280 yd^3/day (for sites greater than 1,000,000 ft^2).

The geotextile layer will be installed using the four site laborers as the sand filter layer is installed. It is assumed that the four laborers can place the geotextile at a rate that is equal to the placement of the sand filter layer. Therefore, one additional day will be added to the schedule for placement of the geotextile.

During the construction of the cap system a cap performance monitoring system will be constructed. To account for the performance monitoring system cost, an assumed $5,000 lump sum amount is provided in the cost estimate.

The side slopes of the cap will be armored with riprap material. This material will be placed 12 in. thick around the entire perimeter of the site.

- Material placement rate = 100 yd^3/hour
- Volume of riprap material needed = 3,620 yd^3.

During cap construction, construction surveys will be performed following the construction of select cap layers. The surveys will check the grades on the placed landfill layers and establish grade stakes for the next cap layer. Each of the surveys is assumed to add an additional day (survey to start so that it is completed 1 day after establishing cap layer). Therefore, the duration of cap construction will be increased by 7 days for construction surveys.

Cap construction duration is calculated as follows;

- Graded fill layer* 185,470 yd^3 @ 2,560 yd^3/day = 73 days
- Asphalt base course layer 165,107 yd^2 @ 9,090 yd^2/day = 18 days
- Low permeable asphalt layer* 165,107 yd^2 @ 4,904 yd^2/day = 34 days
- Lateral drainage layer* 27,323 yd^3 @ 2,560 yd^3/day = 11 days
- Gravel filter layer* 27,233 yd^3 @ 2,560 yd^3/day = 11 days
- Sand filter layer* 26,573 yd^3 @ 2,560 yd^3/day = 11 days
- Compacted silt loam layer* 86,876 yd^3 @ 2,560 yd^3/day = 34 days
- Silt loam and pea gravel layer* 87,856 yd^3 @ 2,560 yd^3/day = 35 days
- Cap berm 5,209 yd^3 @ 1,280 yd^3/day = 4 days
- Riprap 3,620 yd^3 @ 800 yd^3/day = 5 days

- Geotextile placement (as per assumptions additional days) = 1 day
- Surveys (as per assumptions additional days) = 7 days
- Total days to construct cap system = 244 days.

* Perform construction survey following the installation of this cap layer.

Air sampling will be conducted on a daily basis during the construction of the first layer of the cap system. Using the assumed production rate of 320 yd^3/hour (2,560 yd^3/day) the time required to install the first layer of the cap system is calculated as follows:

- Volume of first cap layer = 185,470 yd^3
- Days to install first cap layer = 185,470 yd^3 / 2,560 yd^3/day
  = 73 days

Vegetation: Following the installation of the cap, the silt loam with pea gravel will be vegetated (the top surface area of the cap system). It is expected that the area can be vegetated at a rate of 1,000 yd^2/day with one crew, 2,000 yd^2/day with two crews (two crew used when vegetation areas exceed 100,000 ft^2 but are less than 1,000,000 ft^2), and 4,000 yd^2/day with four crews (four crews used when vegetation areas exceed 1,000,000 ft^2). Vegetation costs are based on the following:

- Area to be vegetated = 1,431,213 ft^2
  = 159,023 yd^2
- Number of crews (1,000 yd^2/day each) = 4 crews
- Vegetation (includes lime, fertilizer, and seed) = \$1.67/yd^2
- Day to vegetate area = 159,023 yd^2 / 4,000 yd^2/day
  = 40 days

Dust Suppression: Dust suppression is required for the duration of site preparation, capping, and vegetation to minimize the generation of on site fugitive dust. A water truck will be rented fro this duration. Cost for dust suppression is based on the following:

- Duration of site preparation = 76 days
- Duration of capping = 244 days
- Duration of vegetation = 40 days
- Duration of dust suppression = 360 days
- Labor (water truck driver) = \$296/day + truck rental.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. In addition, four laborers will be on site to construct and remove the decontamination pad, perform decontamination activities and install the geotextile material. Miscellaneous costs are calculated as follows:

- Duration of contactor support = 375 days
- Contractor support rate = \$237/hour (see general assumptions)

= $1,896/day

- Four laborers (daily rate) = $37/hour x 8 hour/day x 4 laborers
  = $1,184/day

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system (including berm) = 1,518,645 ft^2
  - Number of two-hour increments = 1,518,645 ft^2 / 12,500 ft^2 = 122
  - Team hours to complete inspections = 30.5 days (2 hours for every 12,500 ft^2)
  - Hourly inspection rate (2 people) = $112/hour ($56/hour/person)
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2
    = $304,000/event
- Cap maintenance (footprint of cap system)
  - Area of cap system (including berm) = 1,518,645 ft^2
  - Area requiring repair (10% of total area) = 151,865 ft^2
    = 16,874 yd^2
  - Volume of Cap repair (2 ft) = 11,249 yd^3
  - Oversight (soil placement 160 yd^3/hour) = 9 days
  - Oversight (vegetation 2,000 yd^2/day) = 9 days

Oversight performed by one Fluor Hanford Engineer at $56/hour or $448/day.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.4.3 Representative Site 216-U-14 Ditch (Cost tables D-35 through D-38)

The site work was estimated to take 47.6 weeks (11.3 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and evaluating landfill limits.

- Prepare site: 54 days (10.8 weeks)

- Capping: 150 days (30 weeks)
- Revegetation: 19 day (3.8 weeks)
- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

Total construction duration = 238 days = 47.6 weeks = 11.3 months.

Site Description: The following information can be found on Table D-63.

- Area of contaminated mass = 5,680 ft x 4 ft = 22,720 ft^2
- Area of cap with 20-ft overrun = [5,680 ft + (40 ft)] x [4 ft + (40 ft)] = 5,720 ft x 44 ft = 251,680 ft^2
- Slope of rise and run of cap = 2H:1V (2 horizontal to 1 vertical)
- Length of rise = 40 in. / (12 in/ft) x 2 x 2 = 13.33 ft
- Length of run = 108 in. / (12 in/ft) x 2 x 2 = 36 ft
- Cap area total length = 5,720 ft + 13.33 ft + 36 ft = 5,769.33 ft
- Cap area total width = 44 ft + 13.33 ft + 36 ft = 93.33 ft
- Area of cap footprint = 5,769.33 ft x 93.33 ft = 538,452 ft^2 = 12.36 acres.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of construction oversight = 238 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT decontamination Crew = 1 day
- RCT crew rate = $1,792/day (see assumptions).

Fluor Hanford Sampling: As indicated in the general assumptions, Fluor Hanford will provide an air sampling crew to collect air samples during dynamic compaction and placement of the first cap layer. Samples will be collected at a rate of one sample per day of activity. The cost for sampling is based on the following:

- Duration of dynamic compaction = 54 days (see below)
- Duration to install first cap layer = 48 days (see below)
- Total number of air samples = 102 samples (1 sample/day)
- Sampling crew (sample and RCT) = $896/day (see assumptions).

Mobilization/Demobilization and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating cost of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- One hydraulic excavator and one operator (on-site borrow source)
- One front-end loader and one operator (on-site borrow source)
- One bulldozer and one operator (on site)
- One front-end loader and one operator (on site)
- One grader and one operator (on site)
- One water truck and one driver
- Five dump trucks and five drivers
- One vibratory roller and one operator (on site)
- One office trailer
- One storage trailer
- Four laborers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hour/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and following the installation of identified cap layers (7 layers). The cost for a single construction survey is based on the following:

Area of construction survey = area of cap footprint + 20% = 538,452 ft^2 + 20% = 646,142 ft^2 = 14.83 acre.

Total surveys performed = 8.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Haul Road Construction = \$7.36/yd^2.

Decontamination Pad: A decontamination pad will be constructed to clean the dynamic compaction equipment. It is assumed that the dynamic compaction equipment can be decontaminated for reuse and can be decontaminated in one day. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting (60 mil LLDPE), PVC pipe, and a sump with a pump and hoses. Based on the Alternative 3 assumption for decontamination pad water use (1,000 gallons per month), 50 gallons of water are required for one day of decontamination activity. Therefore, it is assumed that a temporary water source can be obtained for decontamination activities and large storage tanks will not be required. It is also assumed that the sump can adequately store the rinse water prior to using for dust suppression on contaminated sites. Decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
  = 402 linear feet
  = 0.402m board ft
- Plastic sheeting = (20 ft x 30 ft) + (2 x 8 ft overlap) + 10%
  = 1,188 ft^2
- 3 in. PVC pipe = 5 linear ft.

All equipment rented for the decontamination pad will be rented for the duration of the RA activities, in the event that the decontamination pad is needed. It is assumed that equipment can be decontaminated for reuse.

The decontamination pad will be staffed for one day to decontaminate the dynamic compaction equipment following site stabilization. The decontamination crew will consist of four laborers. This crew will construct the decontamination pad, provide decontamination services, and remove the decontamination pad during demobilization activities (labor provided under miscellaneous costs).

Site Preparation: Costs associated with site preparation are capital costs. Before installing the cap system, the site surface must be prepared. Surface preparation includes stabilization of the cap area using dynamic compaction. The FS indicates a need to ensure compaction of soils at depth (i.e., compaction of soil deeper than 2 ft). To avoid the time delay associated with surcharging the area, a crane will be used to drop a large weight over the cap area. Dynamic compaction was selected during the FS process as a baseline technology and for costing purposes; other compaction processes may be selected during the design process. For cap areas greater than 1,000,000 ft^2, four dynamic compactors will be mobilized to the site. For cap areas greater than 100,000 ft^2 but less than 1,000,000 ft^2, two dynamic compactors will be mobilized to the site. Lastly, for cap areas less than 100,000 ft^2, one dynamic compactor will be mobilized to the site. The cost of site preparation is calculated as follows:

- Footprint of cap = 538,452 ft^2
- Production rate per compactor = 5,000 ft^2/day (assumed)
- Two compactors = 10,000 ft^2/day
- Time required for dynamic compaction = 54 days
- Days air sampling support required = 54 days.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 55 days.

Installation of Cap System: Representative Site 216-U-14 pond requires a Modified RCRA Subtitle C Barrier. The Modified RCRA Subtitle C Barrier design consists of, from bottom to top, the following layers:

- Graded fill layer (40 in. thick)
- Asphalt base course (4 in. thick)
- Low-permeability asphalt layer (6 in. thick)
- Lateral drainage layer (6 in. thick)
- Gravel filter layer (6 in. thick)
- Sand filter layer (6 in. thick)
- Non-woven geotextile
- Compacted silt loam (20 in. thick)
- Silt loam topsoil with pea gravel admixture (20 in. thick)
- Vegetation.

Total cap thickness = 108 in = 9 ft.

The volume of material for these layers is calculated using the area of the site and adding a 20-ft overrun in each direction to ensure complete site coverage. Assume 2H:1V side slopes. Refer to Table D-63 for site dimensions. These areas and volumes will be used for the cost estimate:

• Area of the site	= 22,720 ft^2
• Total area of the cap (area of site + 20 ft overrun)	= 251,680 ft^2
• Footprint of capped area	= 538,452 ft^2
• Graded fill (40 in. sloped at 2%)	= 61,661 yd^3
• Asphalt base course (4 in.)	= 51,162 yd^2
• Low-permeability asphalt (6 in.)	= 51,162 yd^2
• Lateral drainage layer (6 in.)	= 8,059 yd^3
• Gravel filter layer (6 in.)	= 7,843 yd^3
• Sand filter layer (6 in.)	= 6,256 yd^3
• Nonwoven geotextile	= 337,803 ft^2
	= 37,534 yd^2
• Compacted silt loam (20 in.)	= 16,723 yd^3
• Silt loam with pea gravel (20 in.)	= 19,101 yd^3
• 10% of mix is pea gravel	= 1,910 yd^3
• Graded fill for cap berm	= 12,606 yd^3.

The production rate assumes that the haul rate for the cap materials is 160 yd^3/hour or 1,280 yd^3/day (if the cap area is less than 1,000,000 ft^2) and 320 yd^3/hour or 2,560 yd^3/day (if the cap area is greater than 1,000,000 ft^2). The rate at which the cap materials can be placed and graded is assumed equal to the rate material is delivered. Additionally, it is assumed that the pea gravel will be mixed with the silt loam in place. A bulldozer with a tiller attachment will be used to spread both the silt loam and pea gravel. While placing the pea gravel, the tiller attachment will blend the two materials.

Paving rates are based on 4,545 yd^2/day (areas less than 100,000 ft^2) and 9,090 yd^2/day (area greater than 100,000 ft^2) for the four inch sub-grade layer. For the six inch layer, paving rates equal 2,452 yd^2/day (areas less than 100,000 ft^2) and 4,904 yd^2/day (areas greater than 100,000 ft^2).

Due to the size and shape of the cap berm, the production rate is assumed to be ½ the production rates used for placing soils over large areas. The production rates for the cap berm equal 80 yd^3/hour or 640 yd^3/day (for sites less than 1,000,000 ft^2) and 160 yd^3/hour or 1,280 yd^3/day (for sites greater than 1,000,000 ft^2).

The geotextile layer will be installed using the four site laborers as the sand filter layer is installed. It is assumed that the four laborers can place the geotextile at a rate that is equal to the placement of the sand filter layer. Therefore, one additional day will be added to the schedule for placement of the geotextile.

During the construction of the cap system a cap performance monitoring system will be constructed. To account for the performance monitoring system cost, an assumed $5,000 lump sum amount is provided in the cost estimate.

The side slopes of the cap will be armored with riprap material. This material will be placed 12 in. thick around the entire perimeter of the site.

- Material placement rate = 100 yd^3/hour
- Volume of riprap material needed = 8,686 yd^3.

During cap construction, construction surveys will be performed following the construction of select cap layers. The surveys will check the grades on the placed landfill layers and establish grade stakes for the next cap layer. Each of the surveys is assumed to add an additional day (survey to start so that it is completed 1 day after establishing cap layer). Therefore, the duration of cap construction will be increased by 7 days for construction surveys.

Cap construction duration is calculated as follows;

• Graded fill layer*	61,661 yd^3 @ 1,280 yd^3/day	= 48 days
• Asphalt base course layer	51,162 yd^2 @ 9,090 yd^2/day	= 6 days
• Low permeable asphalt layer*	51,162 yd^2 @ 4,904 yd^2/day	= 11 days
• Lateral drainage layer*	8,059 yd^3 @ 1,280 yd^3/day	= 7 days
• Gravel filter layer*	7,843 yd^3 @ 1,280 yd^3/day	= 6 days
• Sand filter layer*	6,256 yd^3 @ 1,280 yd^3/day	= 5 days
• Compacted silt loam layer*	16,723 yd^3 @ 1,280 yd^3/day	= 13 days

• Silt loam and pea gravel layer*	19,101 yd^3 @ 1,280 yd^3/day	= 15 days
• Cap berm	12,606 yd^3 @ 640 yd^3/day	= 20 days
• Riprap	8,686 yd^3 @ 800 yd^3/day	= 11 days
• Geotextile placement	(as per assumptions additional days)	= 1 day
• Surveys	(as per assumptions additional days)	= 7 days
• Total days to construct cap system		= 150 days.

* Perform construction survey following the installation of this cap layer.

Air sampling will be conducted on a daily basis during the construction of the first layer of the cap system. Using the assumed production rate of 160 yd^3/hour (1,280 yd^3/day) the time required to install the first layer of the cap system is calculated as follows:

- Volume of first cap layer = 61,661 yd^3
- Days to install first cap layer = 61,661 yd^3 / 1,280 yd^3/day
  = 48 days

Vegetation: Following the installation of the cap, the silt loam with pea gravel will be vegetated (the top surface area of the cap system). It is expected that the area can be vegetated at a rate of 1,000 yd^2/day with one crew, 2,000 yd^2/day with two crews (two crew used when vegetation areas exceed 100,000 ft^2 but are less than 1,000,000 ft^2), and 4,000 yd^2/day with four crews (four crews used when vegetation areas exceed 1,000,000 ft^2). Vegetation costs are based on the following:

- Area to be vegetated = 328,711 ft^2
  = 36,523 yd^2
- Number of crews (1,000 yd^2/day each) = 2 crews
- Vegetation (includes lime, fertilizer, and seed) = \$1.67/yd^2
- Day to vegetate area = 36,523 yd^2 / 2,000 yd^2/day
  = 19 days

Dust Suppression: Dust suppression is required for the duration of site preparation, capping, and vegetation to minimize the generation of on site fugitive dust. A water truck will be rented fro this duration. Cost for dust suppression is based on the following:

- Duration of site preparation = 54 days
- Duration of capping = 150 days
- Duration of vegetation = 19 days
- Duration of dust suppression = 223 days
- Labor (water truck driver) = \$296/day + truck rental.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. In addition, four laborers will be on site to construct and remove the decontamination pad, perform decontamination activities and install the geotextile material. Miscellaneous costs are calculated as follows:

- Duration of contactor support = 238 days
- Contractor support rate = \$237/hour (see general assumptions)
  = \$1,896/day
- Four laborers (daily rate) = \$37/hour x 8 hour/day x 4 laborers
  = \$1,184/day

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system (including berm) = 538,452 ft^2
  - Number of two-hour increments = 538,452 ft^2 / 12,500 ft^2 = 43
  - Team hours to complete inspections = 10.75 days (2 hours for every 12,500 ft^2)
  - Hourly inspection rate (2 people) = \$112/hour (\$56/hour/person)
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2
    = \$108,000/event
- Cap maintenance (footprint of cap system)
  - Area of cap system (including berm) = 538,452 ft^2
  - Area requiring repair (10% of total area) = 53,845 ft^2
    = 5,982 yd^2
  - Volume of cap repair (2 ft) = 3,988 yd^3
  - Oversight (soil placement 160 yd^3/hour) = 3 days
  - Oversight (vegetation 2,000 yd^2/day) = 3 days

Oversight performed by one Fluor Hanford Engineer at \$56/hour or \$448/day.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.4.4 Representative Site 216-Z-11 Ditch (Cost tables D-39 through D-42)

Representative Site 216-Z-11 Ditch is a group site that contains Sites 216-Z-11, 216-Z-1D, 216-Z-19, UPR-200-W-110, and 216-Z-20. The composite area for this group of sites is 72,900 ft^2 [(2,765 ft x 24 ft) + (1,635 ft x 4 ft)]. The total length of the site is 4,400 ft. As indicated 1,635 ft has a width of 4 ft and the remainder has a width of 24 feet. In order to make calculations more clear to follow, a constant width of 20 ft will be used for a length of 3,645 ft (72,900 ft^2).

The site work was estimated to take 79 weeks (18.8 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and evaluating landfill limits.
- Prepare site: 60 days (12 weeks)
- Capping: 300 days (60 weeks)
- Revegetation: 20 day (4 weeks)
- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

Total construction duration = 395 days = 79 weeks = 18.8 months.

Site Description: The following information has been calculated using the equivalent site area.

- Area of contaminated mass = 3,645 ft x 20 ft = 72,900 ft^2
- Area of cap with 20-ft overrun = [3,645 ft + (40 ft)] x [20 ft + (40 ft)]
  = 3,685 ft x 60 ft = 221,100 ft^2
- Slope of rise and run of cap = 2H:1V (2 horizontal to 1 vertical)
- Length of rise = 98 in. / (12 in/ft) x 2 x 2 = 32.67 ft
- Length of run = 198 in. / (12 in/ft) x 2 x 2 = 66 ft
- Cap area total length = 3,685 ft + 32.67 ft + 66 ft = 3,783.67 ft
- Cap area total width = 60 ft + 32.67 ft + 66 ft = 158.67 ft
- Total area of cap = 3,783.67 ft x 158.67 ft = 600,355 ft^2
  = 13.78 acres.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of construction oversight = 395 days
- Construction oversight rate = $1,720/day (see assumptions)
- Duration of RCT decontamination Crew = 1 day
- RCT crew rate = $1,792/day (see assumptions)

Fluor Hanford Sampling: As indicated in the general assumptions, Fluor Hanford will provide an air sampling crew to collect air samples during dynamic compaction and placement of the first cap layer. Samples will be collected at a rate of one sample per day of activity. The cost for sampling is based on the following:

- Duration of dynamic compaction = 60 days (see below)
- Duration to install first cap layer = 26 days (see below)
- Total number of air samples = 86 samples (1 sample/day)
- Sampling crew (sample and RCT) = $896/day (see assumptions)

Mobilization/Demobilization and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating cost of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- One hydraulic excavator and one operator (on-site borrow source)
- One front-end loader and one operator (on-site borrow source)
- One bulldozer and one operator (on site)
- One front-end loader and one operator (on site)
- One grader and one operator (on site)
- One water truck and one driver
- Five dump trucks and five drivers
- One vibratory roller and one operator (on site)
- One office trailer
- One storage trailer
- Four laborers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hour/day x $37/hour = $592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and following the installation of identified cap layers (8 layers). The cost for a single construction survey is based on the following:

Area of construction survey = area of cap footprint + 20% = 600,355 ft^2 + 20% = 720,426 ft^2 = 16.54 acre.

Total surveys performed = 9.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Haul Road Construction = $7.36/$yd^2$.

Decontamination Pad: A decontamination pad will be constructed to clean the dynamic compaction equipment. It is assumed that the dynamic compaction equipment can be decontaminated for reuse and can be decontaminated in one day. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting (60 mil LLDPE), PVC pipe, and a sump with a pump and hoses. Based on the Alternative 3 assumption for decontamination pad water use (1,000 gallons per month), 50 gallons of water are required for one day of decontamination activity. Therefore, it is assumed that a temporary water source can be obtained for decontamination activities and large storage tanks will not be required. It is also assumed that the sump can adequately store the rinse water prior to using for dust suppression on contaminated sites. Decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
  = 402 linear feet
  = 0.402m board ft
- Plastic sheeting = (20 ft x 30 ft) + (2 x 8 ft overlap) + 10%
  = 1,188 ft^2
- 3 in. PVC pipe = 5 linear ft.

All equipment rented for the decontamination pad will be rented for the duration of the RA activities, in the event that the decontamination pad is needed. It is assumed that equipment can be decontaminated for reuse.

The decontamination pad will be staffed for one day to decontaminate the dynamic compaction equipment following site stabilization. The decontamination crew will consist of four laborers. This crew will construct the decontamination pad, provide decontamination services, and remove the decontamination pad during demobilization activities (labor provided under miscellaneous costs).

Site Preparation: Costs associated with site preparation are capital costs. Before installing the cap system, the site surface must be prepared. Surface preparation includes stabilization of the cap area using dynamic compaction. The FS indicates a need to ensure compaction of soils at depth (i.e., compaction of soil deeper than 2 ft). To avoid the time delay associated with surcharging the area, a crane will be used to drop a large weight over the cap area. Dynamic compaction was selected during the FS process as a baseline technology and for costing purposes; other compaction processes may be selected during the design process.

For cap areas greater than 1,000,000 ft^2, four dynamic compactors will be mobilized to the site. For cap areas greater than 100,000 ft^2 but less than 1,000,000 ft^2, two dynamic compactors will be mobilized to the site. Lastly, for cap areas less than 100,000 ft^2, one dynamic compactor will be mobilized to the site. The cost of site preparation is calculated as follows:

- Footprint of cap = 600,355 ft^2
- Production rate per compactor = 5,000 ft^2/day (assumed)
- Two compactors = 10,000 ft^2/day
- Time required for dynamic compaction = 60 days
- Days air sampling support required = 60 days

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 61 days.

Installation of Cap System: Representative Site 216-Z-11 Ditch group requires a Hanford Barrier. The Hanford Barrier design consists of, from bottom to top, the following layers:

- Compacted soil foundation (18 in. avg.)
- Top course (4 in.)
- Low-permeability asphalt layer (6 in.)
- Drainage gravel/cushion (12 in.)
- Fractured basalt riprap (60 in.)
- Gravel filter (12 in.)
- Sand filter (6 in.)
- Compacted silt loam (40 in.)
- Silt loam with pea gravel admixture
- Vegetation.

Total cap thickness = 198 in = 16.5 ft.

The volume of material for these layers is calculated using the area of the site and adding a 20-ft overrun in each direction to ensure complete site coverage. Assume 2H:1V side slopes. Refer to Table D-63 for site dimensions. These areas and volumes will be used for the cost estimate:

- Area of the site = 72,900 ft^2
- Total area of cap (area of cap + 20 ft overrun) = 221,100 ft^2
- Footprint of capped area = 600,355 ft^2
- Soil foundation (18 in. sloped at 2%) = 32,697 yd^3
- Top course (4 in.) = 64,082 yd^2
- Low-permeability asphalt = 64,082 yd^2
- Drainage gravel/cushion (12 in.) = 20,585 yd^3
- Fractured basalt riprap = (volume of total cap + berms) = 217,612 yd^3
- Gravel filter (12 in.) = 13,299 yd^3

- Sand filter (6 in.) = 6,649 yd^3
- Compacted silt loam (40 in.) = 33,178 yd^3
- Silt loam with pea gravel admixture (40 in) = 39,406 yd^3
- - 10% of mix is pea gravel = 3,941 yd^3.

The production rate assumes that the haul rate for the cap materials is 160 yd^3/hour or 1,280 yd^3/day (if the cap area is less than 1,000,000 ft^2) and 320 yd^3/hour or 2,560 yd^3/day (if the cap area is greater than 1,000,000 ft^2). The rate at which the cap materials can be placed and graded is assumed equal to the rate material is delivered. Additionally, it is assumed that the pea gravel will be mixed with the silt loam in place. A bulldozer with a tiller attachment will be used to spread both the silt loam and pea gravel. While placing the pea gravel, the tiller attachment will blend the two materials.

Paving rates are based on 4,545 yd^2/day (areas less than 100,000 ft^2) and 9,090 yd^2/day (areas greater than 100,000 ft^2) for the four inch sub-grade layer. For the six inch layer, paving rates equal 2,452 yd^2/day (areas less than 100,000 ft^2) and 4,904 yd^2/day (areas greater than 100,000 ft^2).

The cap berm in a Hanford Cap System is part of the fractured basalt riprap layer. Production rates for the fractured basalt riprap including berm is assumed to equal 100 yd^3/hour or 800 yd^3/day. Due to the large volume of riprap that needs to be placed two riprap crews will be included (production rate equals 1,600 yd^3/day).

During the construction of the cap system a cap performance monitoring system will be constructed. To account for the performance monitoring system cost, an assumed $5,000 lump sum amount is provided in the cost estimate.

During cap construction, construction surveys will be performed following the construction of select cap layers. The surveys will check the grades on the placed landfill layers and establish grade stakes for the next cap layer. Each of the surveys is assumed to add an additional day (survey to start so that it is completed 1 day after establishing cap layer). Therefore, the duration of cap construction will be increased by 8 days for construction surveys.

Cap construction duration is calculated as follows;

• Foundation Soil*	32,697 yd^3 @ 1,280 yd^3/day	= 26 days
• Top course asphalt layer	64,082 yd^2 @ 4,545 yd^2/day	= 14 days
• Low permeable asphalt layer*	64,082 yd^2 @ 2,452 yd^2/day	= 26 days
• Drainage gravel/cushion layer*	20,585 yd^3 @ 1,280 yd^3/day	= 16 days
• Fractured basalt riprap*	217,612 yd^3 @ 1,600 yd^3/day	= 136 days
• Gravel filter layer*	13,299 yd^3 @ 1,280 yd^3/day	= 11 days
• Sand filter layer*	6,649 yd^3 @ 1,280 yd^3/day	= 6 days
• Compacted silt loam layer*	33,178 yd^3 @ 1,280 yd^3/day	= 26 days
• Silt loam and pea gravel layer*	39,406 yd^3 @ 1,280 yd^3/day	= 31 days
• Surveys	(as per assumptions additional days)	= 8 days

- Total days to construct cap system = 300 days.

* Perform construction survey following the installation of this cap layer.

Air sampling will be conducted on a daily basis during the construction of the first layer of the cap system. Using the assumed production rate of 320 yd^3/hour (2,560 yd^3/day) the time required to install the first layer of the cap system is calculated as follows:

- Volume of first cap layer = 32,697 yd^3
- Days to install first cap layer = 32,697 yd^3 / 1,280 yd^3/day
  = 26 days

Vegetation: Following the installation of the cap, the silt loam with pea gravel will be vegetated (the top surface area of the cap system). It is expected that the area can be vegetated at a rate of 1,000 yd^2/day with one crew, 2,000 yd^2/day with two crews (two crew used when vegetation areas exceed 100,000 ft^2 but are less than 1,000,000 ft^2), and 4,000 yd^2/day with four crews (four crews used when vegetation areas exceed 1,000,000 ft^2). Vegetation costs are based on the following:

- Area to be vegetated = 344,504 ft^2
  = 38,278 yd^2
- Number of crews (1,000 yd^2/day each) = 2 crews
- Vegetation (includes lime, fertilizer, and seed) = \$1.67/yd^2
- Day to vegetate area = 38,278 yd^2/2,000 yd^2/day
  = 20 days

Dust Suppression: Dust suppression is required for the duration of site preparation, capping, and vegetation to minimize the generation of on site fugitive dust. A water truck will be rented fro this duration. Cost for dust suppression is based on the following:

- Duration of site preparation = 60 days
- Duration of capping = 300 days
- Duration of vegetation = 20 days
- Duration of dust suppression = 380 days
- Labor (water truck driver) = \$296/day + truck rental.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. In addition, four laborers will be on site to construct and remove the decontamination pad, perform decontamination activities and install the geotextile material. Miscellaneous costs are calculated as follows:

- Duration of contactor support = 395 days
- Contractor support rate = \$237/hour (see general assumptions)
  = \$1,896/day
- Four laborers (daily rate) = \$37/hour x 8 hour/day x 4 laborers

= $1,184/day

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

- Area of cap system (including berm)	= 600,355 ft^2
- Number of two-hour increments	= 600,355 ft^2 / 12,500 ft^2 = 48
- Team hours to complete inspections	= 12 days (2 hours for every 12,500 ft^2)
- Hourly inspection rate (2 people)	= $112/hour ($56/hour/person)
- Radiation surveys of surface soil	= $1,000 for every 5,000 ft^2
	= $120,000/event

- Cap maintenance (footprint of cap system)

- Area of cap system (including berm)	= 600,355 ft^2
- Area requiring repair (10% of total area)	= 60,036 ft^2
	= 6,671 yd^2
- Volume of cap repair (2 ft)	= 4,447 yd^3
- Oversight (soil placement 160 yd^3/hour)	= 4 days
- Oversight (vegetation 1,000 yd^2/day)	= 7 days

Oversight performed by one Fluor Hanford Engineer at $56/hour or $448/day.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.4.5 Representative Site 216-A-25 Gable Mountain Pond (Cost tables D-43 through D-46)

The site work was estimated to take 146 weeks (34.8 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and evaluating landfill limits.

- Prepare site: 154 days (30.8 weeks)

- Capping: 481 days (96.2 weeks)

- Revegetation: 80 day (16 weeks)

- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

Total construction duration = 730 days = 146 weeks = 34.8 months.

Site Description: The following information can be found on Table D-63.

- Area of contaminated mass = 3,800 ft x 700 ft = 2,660,000 ft^2
- Area of cap with 20-ft overrun = [3,800 ft + (40 ft)] x [700 ft + (40 ft)]
  = 3,840 ft x 740 ft = 2,841,600 ft^2
- Slope of rise and run of cap = 2H:1V (2 horizontal to 1 vertical)
- Length of rise = 40 in. / (12 in/ft) x 2 x 2 = 13.33 ft
- Length of run = 108 in. / (12 in/ft) x 2 x 2 = 36 ft
- Cap area total length = 3,840 ft + 13.33 ft + 36 ft = 3,889.33 ft
- Cap area total width = 740 ft + 13.33 ft + 36 ft = 789.33 ft
- Area of cap footprint = 3,889.33 ft x 789.33 ft = 3,069,965 ft^2
  = 70.48 acres.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of construction oversight = 730 days
- Construction oversight rate = \$1,720/day (see assumptions)
- Duration of RCT decontamination Crew = 1 day
- RCT crew rate = \$1,792/day (see assumptions).

Fluor Hanford Sampling: As indicated in the general assumptions, Fluor Hanford will provide an air sampling crew to collect air samples during dynamic compaction and placement of the first cap layer. Samples will be collected at a rate of one sample per day of activity. The cost for sampling is based on the following:

- Duration of dynamic compaction = 154 days (see below)
- Duration to install first cap layer = 147 days (see below)
- Total number of air samples = 301 samples (1 sample/day)
- Sampling crew (sample and RCT) = \$896/day (see assumptions).

Mobilization/Demobilization and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating cost of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Two hydraulic excavators and two operators (on-site borrow source)
- Two front-end loaders and two operators (on-site borrow source)
- Two bulldozers and two operators (on site)
- Two front-end loaders and two operators (on site)
- One grader and one operator (on site)
- One water truck and one driver
- Ten dump trucks and ten drivers
- Two vibratory rollers and two operators (on site)
- One office trailer
- One storage trailer
- Four laborers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hour/day x $37/hour = $592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and following the installation of identified cap layers (7 layers). The cost for a single construction survey is based on the following:

Area of construction survey = area of cap footprint + 20% = 3,069,965 ft^2 + 20% = 3,683,958 ft^2 = 84.57 acre.

Total surveys performed = 8.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Haul Road Construction = $7.36/$yd^2$.

Decontamination Pad: A decontamination pad will be constructed to clean the dynamic compaction equipment. It is assumed that the dynamic compaction equipment can be decontaminated for reuse and can be decontaminated in one day. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting (60 mil LLDPE), PVC pipe, and a sump with a pump and hoses. Based on the Alternative 3 assumption for decontamination pad water use (1,000 gallons per month), 50 gallons of water are required for one day of decontamination activity. Therefore, it is assumed that a temporary water source can be obtained for decontamination activities and large storage tanks will not be required. It is also assumed that the sump can adequately store the rinse water prior to using for dust suppression on contaminated sites. Decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
  = 402 linear feet
  = 0.402m board ft
- Plastic sheeting = (20 ft x 30 ft) + (2 x 8 ft overlap) + 10%
  = 1,188 ft^2
- 3 in. PVC pipe = 5 linear ft.

All equipment rented for the decontamination pad will be rented for the duration of the RA activities, in the event that the decontamination pad is needed. It is assumed that equipment can be decontaminated for reuse.

The decontamination pad will be staffed for one day to decontaminate the dynamic compaction equipment following site stabilization. The decontamination crew will consist of four laborers. This crew will construct the decontamination pad, provide decontamination services, and remove the decontamination pad during demobilization activities (labor provided under miscellaneous costs).

Site Preparation: Costs associated with site preparation are capital costs. Before installing the cap system, the site surface must be prepared. Surface preparation includes stabilization of the cap area using dynamic compaction. The FS indicates a need to ensure compaction of soils at depth (i.e., compaction of soil deeper than 2 ft). To avoid the time delay associated with surcharging the area, a crane will be used to drop a large weight over the cap area. Dynamic compaction was selected during the FS process as a baseline technology and for costing purposes; other compaction processes may be selected during the design process. For cap areas greater than 1,000,000 ft^2, four dynamic compactors will be mobilized to the site. For cap areas greater than 100,000 ft^2 but less than 1,000,000 ft^2, two dynamic compactors will be mobilized to the site. Lastly, for cap areas less than 100,000 ft^2, one dynamic compactor will be mobilized to the site. The cost of site preparation is calculated as follows:

- Footprint of cap = 3,069,965 ft^2
- Production rate per compactor = 5,000 ft^2/day (assumed)
- Four compactors = 20,000 ft^2/day
- Time required for dynamic compaction = 154 days
- Days air sampling support required = 154 days.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 155 days.

Installation of Cap System: Representative Site 216-A-25 pond requires a Modified RCRA Subtitle C Barrier. The Modified RCRA Subtitle C Barrier design consists of, from bottom to top, the following layers:

- Graded fill layer (40 in. thick)
- Asphalt base course (4 in. thick)
- Low-permeability asphalt layer (6 in. thick)
- Lateral drainage layer (6 in. thick)
- Gravel filter layer (6 in. thick)
- Sand filter layer (6 in. thick)
- Non-woven geotextile
- Compacted silt loam (20 in. thick)
- Silt loam topsoil with pea gravel admixture (20 in. thick)
- Vegetation.

Total cap thickness = 108 in = 9 ft.

The volume of material for these layers is calculated using the area of the site and adding a 20-ft overrun in each direction to ensure complete site coverage. Assume 2H:1V side slopes. Refer to Table D-63 for site dimensions. These areas and volumes will be used for the cost estimate:

• Area of the site	= 2,660,000 ft^2
• Total area of the cap (area of site + 20 ft overrun)	= 2,841,000 ft^2
• Footprint of capped area	= 3,069,965 ft^2
• Graded fill (40 in. sloped at 2%)	= 375,168 yd^3
• Asphalt base course (4 in.)	= 334,196 yd^2
• Low-permeability asphalt (6 in.)	= 334,196 yd^2
• Lateral drainage layer (6 in.)	= 55,326 yd^3
• Gravel filter layer (6 in.)	= 55,154 yd^3
• Sand filter layer (6 in.)	= 53,890 yd^3
• Nonwoven geotextile	= 2,910,073 ft^2
	= 323,341 yd^2
• Compacted silt loam (20 in.)	= 176,351 yd^3
• Silt loam with pea gravel (20 in.)	= 178,241 yd^3
• 10% of mix is pea gravel	= 17,824 yd^3
• Graded fill for cap berm	= 10,029 yd^3.

The production rate assumes that the haul rate for the cap materials is 160 yd^3/hour or 1,280 yd^3/day (if the cap area is less than 1,000,000 ft^2) and 320 yd^3/hour or 2,560 yd^3/day (if the cap area is greater than 1,000,000 ft^2). The rate at which the cap materials can be placed and graded is assumed equal to the rate material is delivered. Additionally, it is assumed that the pea gravel will be mixed with the silt loam in place. A bulldozer with a tiller attachment will be used to spread both the silt loam and pea gravel. While placing the pea gravel, the tiller attachment will blend the two materials.

Paving rates are based on 4,545 yd^2/day (areas less than 100,000 ft^2) and 9,090 yd^2/day (area greater than 100,000 ft^2) for the four inch sub-grade layer. For the six inch layer, paving rates equal 2,452 yd^2/day (areas less than 100,000 ft^2) and 4,904 yd^2/day (areas greater than 100,000 ft^2).

Due to the size and shape of the cap berm, the production rate is assumed to be ½ the production rates used for placing soils over large areas. The production rates for the cap berm equal 80 yd^3/hour or 640 yd^3/day (for sites less than 1,000,000 ft^2) and 160 yd^3/hour or 1,280 yd^3/day (for sites greater than 1,000,000 ft^2).

The geotextile layer will be installed using the four site laborers as the sand filter layer is installed. It is assumed that the four laborers can place the geotextile at a rate that is equal to the placement of the sand filter layer. Therefore one additional day will be added to the schedule for placement of the geotextile.

During the construction of the cap system a cap performance monitoring system will be constructed. To account for the performance monitoring system cost, an assumed $5,000 lump sum amount is provided in the cost estimate.

The side slopes of the cap will be armored with riprap material. This material will be placed 12 in. thick around the entire perimeter of the site.

- Material placement rate = 100 yd^3/hour
- Volume of riprap material needed = 6,921 yd^3.

During cap construction, construction surveys will be performed following the construction of select cap layers. The surveys will check the grades on the placed landfill layers and establish grade stakes for the next cap layer. Each of the surveys is assumed to add an additional day (survey to start so that it is completed 1 day after establishing cap layer). Therefore, the duration of cap construction will be increased by 7 days for construction surveys.

Cap construction duration is calculated as follows;

- Graded fill layer* 375,168 yd^3 @ 2,560 yd^3/day = 147 days
- Asphalt base course layer 334,196 yd^2 @ 9,090 yd^2/day = 37 days
- Low permeable asphalt layer* 334,196 yd^2 @ 4,904 yd^2/day = 68 days
- Lateral drainage layer* 55,326 yd^3 @ 2,560 yd^3/day = 22 days
- Gravel filter layer* 55,154 yd^3 @ 2,560 yd^3/day = 22 days
- Sand filter layer* 53,890 yd^3 @ 2,560 yd^3/day = 21 days
- Compacted silt loam layer* 176,351 yd^3 @ 2,560 yd^3/day = 69 days
- Silt loam and pea gravel layer* 178,241 yd^3 @ 2,560 yd^3/day = 70 days
- Cap berm 10,029 yd^3 @ 1,280 yd^3/day = 8 days
- Riprap 6,921 yd^3 @ 800 yd^3/day = 9 days
- Geotextile placement (as per assumptions additional days) = 1 day
- Surveys (as per assumptions additional days) = 7 days
- Total days to construct cap system = 481 days.

* Perform construction survey following the installation of this cap layer.

Air sampling will be conducted on a daily basis during the construction of the first layer of the cap system. Using the assumed production rate of 320 yd^3/hour (2,560 yd^3/day) the time required to install the first layer of the cap system is calculated as follows:

- Volume of first cap layer = 375,168 yd^3
- Days to install first cap layer = 375,168 yd^3 / 2,560 yd^3/day
  = 147 days

Vegetation: Following the installation of the cap, the silt loam with pea gravel will be vegetated (the top surface area of the cap system). It is expected that the area can be vegetated at a rate of 1,000 yd^2/day with one crew, 2,000 yd^2/day with two crews (two crew used when vegetation areas exceed 100,000 ft^2 but are less than 1,000,000 ft^2), and 4,000 yd^2/day with four crews (four crews used when vegetation areas exceed 1,000,000 ft^2). Vegetation costs are based on the following:

- Area to be vegetated = 2,902,844 ft^2
  = 322,538 yd^2
- Number of crews (1,000 yd^2/day each) = 4 crews
- Vegetation (includes lime, fertilizer, and seed) = \$1.67/yd^2
- Day to vegetate area = 322,538 yd^2 / 4,000 yd^2/day
  = 80 days

Dust Suppression: Dust suppression is required for the duration of site preparation, capping, and vegetation to minimize the generation of on site fugitive dust. A water truck will be rented fro this duration. Cost for dust suppression is based on the following:

- Duration of site preparation = 154 days
- Duration of capping = 481 days
- Duration of vegetation = 80 days
- Duration of dust suppression = 715 days
- Labor (water truck driver) = \$296/day + truck rental.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. In addition, four laborers will be on site to construct and remove the decontamination pad, perform decontamination activities and install the geotextile material. Miscellaneous costs are calculated as follows:

- Duration of contactor support = 730 days
- Contractor support rate = \$237/hour (see general assumptions)
  = \$1,896/day
- Four laborers (daily rate) = \$37/hour x 8 hour/day x 4 laborers
  = \$1,184/day

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cap system (including berm) = 3,069,965 ft^2
  - Number of two-hour increments = 3,069,965 ft^2 / 12,500 ft^2 = 246
  - Team hours to complete inspections = 61.5 days (2 hours for every 12,500 ft^2)
  - Hourly inspection rate (2 people) = $112/hour ($56/hour/person)
  - Radiation surveys of surface soil = $1,000 for every 5,000 ft^2 = $614,000/event
- Cap maintenance (footprint of cap system)
  - Area of cap system (including berm) = 3,069,965 ft^2
  - Area requiring repair (10% of total area) = 306,997 ft^2 = 34,111 yd^2
  - Volume of cap repair (2 ft) = 22,740 yd^3
  - Oversight (soil placement 160 yd^3/hour) = 18 days
  - Oversight (vegetation 2,000 yd^2/day) = 17 days

Oversight performed by one Fluor Hanford Engineer at $56/hour or $448/day.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.4.6 Representative Site 216-T-26 Crib (Cost tables D-47 through D-50)

The site work was estimated to take 7.6 weeks (1.8 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and evaluating landfill limits.
- Prepare site: 3 days (0.6 weeks)
- Capping: 19 days (3.8 weeks)
- Revegetation: 1 day (0.2 weeks)

- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

Total construction duration = 38 days = 7.6 weeks = 1.8 months.

Site Description: The following information can be found on Table D-63.

• Area of contaminated mass	= 30 ft x 30 ft = 900 ft^2
• Area of cap with 20-ft overrun	= [30 ft + (40 ft)] x [30 ft + (40 ft)]
	= 70 ft x 70 ft = 4,900 ft^2
• Slope of rise and run of cap	= 2H:1V (2 horizontal to 1 vertical)
• Length of rise	= 40 in. / (12 in/ft) x 2 x 2 = 13.33 ft
• Length of run	= 108 in. / (12 in/ft) x 2 x 2 = 36 ft
• Cap area total length	= 70 ft + 13.33 ft + 36 ft = 119.33 ft
• Cap area total width	= 70 ft + 13.33 ft + 36 ft = 119.33 ft
• Area of cap footprint	= 119.33 ft x 119.33 ft = 14,240 ft^2
	= 0.33 acres.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

• Duration of construction oversight	= 38 days
• Construction oversight rate	= $1,720/day (see assumptions)
• Duration of RCT decontamination Crew	= 1 day
• RCT crew rate	= $1,792/day (see assumptions).

Fluor Hanford Sampling: As indicated in the general assumptions, Fluor Hanford will provide an air sampling crew to collect air samples during dynamic compaction and placement of the first cap layer. Samples will be collected at a rate of one sample per day of activity. The cost for sampling is based on the following:

• Duration of dynamic compaction	= 3 days (see below)
• Duration to install first cap layer	= 2 days (see below)
• Total number of air samples	= 5 samples (1 sample/day)
• Sampling crew (sample and RCT)	= $896/day (see assumptions).

Mobilization/Demobilization and Field Support: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operating cost of a generator (site utilities on cost table) during the construction period. Field office support consists of office trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- One hydraulic excavator and one operator (on-site borrow source)
- One front-end loader and one operator (on-site borrow source)
- One bulldozer and one operator (on site)
- One front-end loader and one operator (on site)
- One grader and one operator (on site)
- One water truck and one driver
- Five dump trucks and five drivers
- One vibratory roller and one operator (on site)
- One office trailer
- One storage trailer
- Four laborers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows:

Mobilization and demobilization time = (1 mob + 1 demob) x 8 hour/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and following the installation of identified cap layers (7 layers). The cost for a single construction survey is based on the following:

Area of construction survey = area of cap footprint + 20% = 14,240 ft^2 + 20% = 17,088 ft^2 = 0.39 acre.

Total surveys performed = 8.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Haul Road Construction = \$7.36/yd^2.

Decontamination Pad: A decontamination pad will be constructed to clean the dynamic compaction equipment. It is assumed that the dynamic compaction equipment can be decontaminated for reuse and can be decontaminated in one day. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting (60 mil LLDPE), PVC pipe, and a sump with a pump and hoses. Based on the Alternative 3 assumption for decontamination pad water use (1,000 gallons per month), 50 gallons of water are required for one day of decontamination activity. Therefore, it is assumed that a temporary water source can be obtained for decontamination activities and large storage tanks will not be required. It is also assumed that the sump can adequately store the rinse water prior to using for dust suppression on contaminated sites. Decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
  = 402 linear feet
  = 0.402m board ft
- Plastic sheeting = (20 ft x 30 ft) + (2 x 8 ft overlap) + 10%
  = 1,188 ft^2
- 3 in. PVC pipe = 5 linear ft.

All equipment rented for the decontamination pad will be rented for the duration of the RA activities, in the event that the decontamination pad is needed. It is assumed that equipment can be decontaminated for reuse.

The decontamination pad will be staffed for one day to decontaminate the dynamic compaction equipment following site stabilization. The decontamination crew will consist of four laborers. This crew will construct the decontamination pad, provide decontamination services, and remove the decontamination pad during demobilization activities (labor provided under miscellaneous costs).

Site Preparation: Costs associated with site preparation are capital costs. Before installing the cap system, the site surface must be prepared. Surface preparation includes stabilization of the cap area using dynamic compaction. The FS indicates a need to ensure compaction of soils at depth (i.e., compaction of soil deeper than 2 ft). To avoid the time delay associated with surcharging the area, a crane will be used to drop a large weight over the cap area. Dynamic compaction was selected during the FS process as a baseline technology and for costing purposes; other compaction processes may be selected during the design process. For cap areas greater than 1,000,000 ft^2, four dynamic compactors will be mobilized to the site. For cap areas greater than 100,000 ft^2 but less than 1,000,000 ft^2, two dynamic compactors will be mobilized to the site. Lastly, for cap areas less than 100,000 ft^2, one dynamic compactor will be mobilized to the site. The cost of site preparation is calculated as follows:

- Footprint of cap = 14,240 ft^2
- Production rate per compactor = 5,000 ft^2/day (assumed)
- One compactor = 5,000 ft^2/day
- Time required for dynamic compaction = 3 days
- Days air sampling support required = 3 days.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 4 days.

Installation of Cap System: Representative Site 216-T-26 crib requires a Modified RCRA Subtitle C Barrier. The Modified RCRA Subtitle C Barrier design consists of, from bottom to top, the following layers:

- Graded fill layer (40 in. thick)
- Asphalt base course (4 in. thick)
- Low-permeability asphalt layer (6 in. thick)
- Lateral drainage layer (6 in. thick)
- Gravel filter layer (6 in. thick)
- Sand filter layer (6 in. thick)
- Non-woven geotextile
- Compacted silt loam (20 in. thick)
- Silt loam topsoil with pea gravel admixture (20 in. thick)
- Vegetation.

Total cap thickness = 108 in = 9 ft.

The volume of material for these layers is calculated using the area of the site and adding a 20-ft overrun in each direction to ensure complete site coverage. Assume 2H:1V side slopes. Refer to Table D-63 for site dimensions. These areas and volumes will be used for the cost estimate:

- Area of the site = 900 ft^2
- Total area of the cap (area of site + 20 ft overrun) = 4,900 ft^2
- Footprint of capped area = 14,240 ft^2
- Graded fill (40 in. sloped at 2%) = 1,573 yd^3
- Asphalt base course (4 in.) = 1,248 yd^2
- Low-permeability asphalt (6 in.) = 1,248 yd^2
- Lateral drainage layer (6 in.) = 191 yd^3
- Gravel filter layer (6 in.) = 184 yd^3
- Sand filter layer (6 in.) = 133 yd^3
- Nonwoven geotextile = 7,186 ft^2
  = 798 yd^2
- Compacted silt loam (20 in.) = 333 yd^3
- Silt loam with pea gravel (20 in.) = 396 yd^3
- 10% of mix is pea gravel = 40 yd^3
- Graded fill for cap berm = 363 yd^3.

The production rate assumes that the haul rate for the cap materials is 160 yd^3/hour or 1,280 yd^3/day (if the cap area is less than 1,000,000 ft^2) and 320 yd^3/hour or 2,560 yd^3/day (if the cap area is greater than 1,000,000 ft^2). The rate at which the cap materials can be placed and graded is assumed equal to the rate material is delivered. Additionally, it is assumed that the pea gravel will be mixed with the silt loam in place. A bulldozer with a tiller attachment will be used to spread both the silt loam and pea gravel. While placing the pea gravel, the tiller attachment will blend the two materials.

Paving rates are based on 4,545 yd^2/day (areas less than 100,000 ft^2) and 9,090 yd^2/day (area greater than 100,000 ft^2) for the four inch sub-grade layer. For the six inch layer, paving rates equal 2,452 yd^2/day (areas less than 100,000 ft^2) and 4,904 yd^2/day (areas greater than 100,000 ft^2).

Due to the size and shape of the cap berm, the production rate is assumed to be ½ the production rates used for placing soils over large areas. The production rates for the cap berm equal 80 yd^3/hour or 640 yd^3/day (for sites less than 1,000,000 ft^2) and 160 yd^3/hour or 1,280 yd^3/day (for sites greater than 1,000,000 ft^2).

The geotextile layer will be installed using the four site laborers as the sand filter layer is installed. It is assumed that the four laborers can place the geotextile at a rate that is equal to the placement of the sand filter layer. Therefore one additional day will be added to the schedule for placement of the geotextile.

During the construction of the cap system a cap performance monitoring system will be constructed. To account for the performance monitoring system cost, an assumed $5,000 lump sum amount is provided in the cost estimate.

The side slopes of the cap will be armored with riprap material. This material will be placed 12 in. thick around the entire perimeter of the site.

- Material placement rate = 100 yd^3/hour
- Volume of riprap material needed = 302 yd^3.

During cap construction, construction surveys will be performed following the construction of select cap layers. The surveys will check the grades on the placed landfill layers and establish grade stakes for the next cap layer. Each of the surveys is assumed to add an additional day (survey to start so that it is completed 1 day after establishing cap layer). Therefore, the duration of cap construction will be increased by 7 days for construction surveys.

Cap construction duration is calculated as follows;

• Graded fill layer*	1,573 yd^3 @ 1,280 yd^3/day	= 2 days
• Asphalt base course layer	1,248 yd^2 @ 4,545 yd^2/day	= 1 day
• Low permeable asphalt layer*	1,248 yd^2 @ 2,452 yd^2/day	= 1 day
• Lateral drainage layer*	191 yd^3 @ 1,280 yd^3/day	= 1 day
• Gravel filter layer*	184 yd^3 @ 1,280 yd^3/day	= 1 day
• Sand filter layer*	133 yd^3 @ 1,280 yd^3/day	= 1 day
• Compacted silt loam layer*	333 yd^3 @ 1,280 yd^3/day	= 1 day
• Silt loam and pea gravel layer*	396 yd^3 @ 1,280 yd^3/day	= 1 day
• Cap berm	363 yd^3 @ 640 yd^3/day	= 1 day
• Riprap	302 yd^3 @ 800 yd^3/day	= 1 day
• Geotextile placement	(as per assumptions additional days)	= 1 day
• Surveys	(as per assumptions additional days)	= 7 days
• Total days to construct cap system		= 19 days.

* Perform construction survey following the installation of this cap layer.

Air sampling will be conducted on a daily basis during the construction of the first layer of the cap system. Using the assumed production rate of 160 yd^3/hour (1,280 yd^3/day) the time required to install the first layer of the cap system is calculated as follows:

- Volume of first cap layer = 1,573 yd^3
- Days to install first cap layer = 1,573 yd^3 / 1,280 yd^3/day
  = 2 days

Vegetation: Following the installation of the cap, the silt loam with pea gravel will be vegetated (the top surface area of the cap system). It is expected that the area can be vegetated at a rate of 1,000 yd^2/day with one crew, 2,000 yd^2/day with two crews (two crew used when vegetation areas exceed 100,000 ft^2 but are less than 1,000,000 ft^2), and 4,000 yd^2/day with four crews (four crews used when vegetation areas exceed 1,000,000 ft^2). Vegetation costs are based on the following:

- Area to be vegetated = 6,944 ft^2
  = 771 yd^2
- Number of crews (1,000 yd^2/day each) = 1 crews
- Vegetation (includes lime, fertilizer, and seed) = \$1.67/yd^2
- Day to vegetate area = 771 yd^2 / 1,000 yd^2/day
  = 1 day

Dust Suppression: Dust suppression is required for the duration of site preparation, capping, and vegetation to minimize the generation of on site fugitive dust. A water truck will be rented fro this duration. Cost for dust suppression is based on the following:

- Duration of site preparation = 3 days
- Duration of capping = 19 days
- Duration of vegetation = 1 days
- Duration of dust suppression = 23 days
- Labor (water truck driver) = \$296/day + truck rental.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. In addition, four laborers will be on site to construct and remove the decontamination pad, perform decontamination activities and install the geotextile material. Miscellaneous costs are calculated as follows:

- Duration of contactor support = 38 days
- Contractor support rate = \$237/hour (see general assumptions)
  = \$1,896/day
- Four laborers (daily rate) = \$37/hour x 8 hour/day x 4 laborers
  = \$1,184/day

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The activities performed during surveillance and cap maintenance are expected to be the same as those described for site inspection/surveillance and existing cover maintenance cost items under Alterative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)

- Area of cap system (including berm)	= 14,240 ft^2
- Number of two-hour increments	= 14,240 ft^2 / 12,500 ft^2 = 2
- Team hours to complete inspections	= 0.5 day (2 hours for every 12,500 ft^2)
- Hourly inspection rate (2 people)	= $112/hour ($56/hour/person)
- Radiation surveys of surface soil	= $1,000 for every 5,000 ft^2
	= $3,000/event

- Cap maintenance (footprint of cap system)

- Area of cap system (including berm)	= 14,240 ft^2
- Area requiring repair (10% of total area)	= 1,424 ft^2
	= 158 yd^2
- Volume of cap repair (2 ft)	= 105 yd^3
- Oversight (soil placement 160 yd^3/hour)	= 1 day
- Oversight (vegetation 1,000 yd^2/day)	= 1 day

Oversight performed by one Fluor Hanford Engineer at $56/hour or $448/day.

Monitoring: Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.5 ALTERNATIVE 5 – REMOVAL, TREATMENT, AND DISPOSAL WITH CAPPING

D3.5.1 General Assumptions

The general assumptions for Alternative 5 are as follows:

- Representative site areas range from 900 ft^2 (216-T-26) to 1,306,449 ft^2 (216-U-10). Because of the difference, selected construction activities for Representative Site 216-U-10 will be done using larger construction crews. Refer to site specific text for production rates.

- Fluor Hanford will provide contractor oversight. Personnel used to perform contractor oversight include a project manager, health and safety manager (half time), QA/QC representative and scheduler, and an RCT. This oversight crew will be used when ever the contractor is in operation. Using the wage rates discussed in Section D3.1, this crew has an hourly rate of $215 or $1,720/day.

- Fluor Hanford will provide a crew of four RCTs for decontamination activities. Using the wage rates discussed in Section D3.1, the crew has an hourly rate of $224 or $1,792/day.

- Fluor Hanford will provide a crew of one sample technician (full time) and one RCT (full time) to collect one air samples each day during excavation, backfilling the first layer of soil, and dynamic compaction. Using the wage rates discussed in Section D3.1, the crew has an hourly rate of $112 or $896/day. The analytical cost for air samples is assumed to equal $1,000/sample. Air samples will be collected using equipment at a cost of $500/day.

- Fluor Hanford will provide a crew of one sample technician (half time) and one RCT (full time) to collect soil samples during excavation activities. Using the wage rates discussed in Section D3.1, the crew has an hourly rate of $84 or $672/day. The analytical costs for soil samples is assumed to equal $1,100 for overburden soil samples tested on-site, $5,000 for contaminated soil samples tested on-site, and $5,000 for overburden or contaminated soil samples tested off-site. Off site samples will be collected a rate of 1 off site sample for every 20 samples collected (5%).

- Fencing and monuments/signs for institutional controls and fencing maintenance are considered institutional costs are not considered in this cost estimate.

- Periodic groundwater monitoring costs will be added to Table D-65 as indicated in Section D3.1.4.

- Following excavation, contaminated soil will remain in place. To keep equipment and personnel off the contaminated soils, it is assumed that the first 10 feet of soil will be placed with out significant compaction. Following the placement of the 10 feet of soil, the soil will be dynamically compacted. The remainder of the excavation will then be backfilled with fill soil to a depth that is 40 inches (3.33 feet) below finished grade.

- Because the highly contaminated soils will be removed from the site, the cap system need only consist of two soil components. These components consist of 20 inches of silt loam and 20 inches of silt loam and pea gravel. In addition, vegetation will be applied to the surface to protect against erosion.

- Excavation depths for Alternative 5 are based on the information presented in the table below. The thickness of the contaminated soil is calculated by subtracting the depth of clean overburden soil from the total depth of excavation. The volume is then calculated by multiplying the area of contamination provided in Table D-64 by the depth. These intervals were developed based on analytical data gathered during the Remedial Investigation (RI).

- The contaminated soil interval for removal in Alternative 5 is equal to the depth required to remove the soil that causes an unacceptable industrial, ecological, and/or intruder near-surface risk. These depths are as follows:

Representative Site	Depth of Clean Overburden Soil (bgs)	Alternative 3 Depth of Contaminated Soil (bgs)	Alternative 5 Total Depth of Excavation (bgs)
216-U-10 Pond	2	210	15
216-U-14 Ditch*	6	15	--
216-Z-11 Ditch*	2	15	--
216-A-25 Pond*	8	15	--
216-T-26 Crib	18	200	20

* The available analytical data indicates that groundwater protection is not required at these sites. Therefore, Alternative 5 is identical to Alternative 3 and is not evaluated for these Representative Sites.

- As indicated in the general assumptions for Alternative 3 (Section D3.3.1), no soil blending is required for ERDF disposal.

- Cap materials will be placed over the entire excavation area and not just the area represented by the site area plus twenty feet of overrun.

- After backfill and placement of fill material and the two cap layers, remaining overburden material shall remain stockpiled on-site. No costs will be attributed to left over overburden materials.

- Alternative 5 consist of five general activities; excavation, disposal, capping, restoration, and periodic maintenance. These activities, along with activities performed during construction mobilization and demobilization, are described for the representative sites in the following sections.

D3.5.2 Representative Site 216-U-10 Pond (Cost tables D-51 through D-54)

This site work was estimated to take 211.8 weeks (50.4 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and construction temporary facilities, performing the site survey, and performing decontamination setup.

- Excavate/dispose: 638 days (127.6 weeks)

- Restore/Cap: 406 days (81.2 weeks) (includes revegetation)

- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

The total construction duration = 1,059 days = 211.8 weeks = 50.4 months.

Site Description: The following information can be found in Table D-64 or on the table presented under general assumptions.

- Area of contaminant mass = 1,143 ft x 1,143 ft = 1,306,449 ft^2
- Depth of overburden soil = 2 ft bgs (see assumptions)
- Total depth of excavation = 15 ft bgs (see assumptions)
- Area of disturbance = 1188 ft x 1188 ft = 1,411,344 ft^2.

The following volumes have been calculated using the site information. This information and quantities used to generate this information is also provided in Table D-64.

- Total excavation volume (based on 1.5H:1V side slopes) = 754,943 yd^3
- Depth of contaminated soil (15 ft – 2 ft) = 13 ft
- Volume of contaminated soil = 629,031 yd^3
- Volume of overburden soil = 125,912 yd^3
- Volume of material to ERDF = 629,031 yd^3
- Overburden available for backfill = 125,912 yd^3
- Total backfill volume required = 754,943 yd^3
- Total offsite fill needed (cap materials) = 172,778 yd^3

  [equals surface (1,411,344 ft^2) area times thickness of cap (40-inches) sloped at 1.5H to 1V, equals ((1,411,344 ft^2 + 1,387,684 ft^2) / 2) x (40 inches / 12 inches/ft) / 27 ft^3/yd^3]
- Cap materials (top layer 20 inches thick) = 86,754 yd^3
  - Pea gravel (10% of volume) = 8,675 yd^3
  - Silt loam (on-site borrow source material) = 78,079 yd^3
- Cap materials (bottom layer 20 inches thick) = 86,024 yd^3
  - Silt loam (on-site borrow source material) = 86,024 yd^3
- Subgrade soil = 456,253 yd^3

  (equals total backfill volume (754,943 yd^3) minus the cap volumes (172,778 yd^3)

As indicated in the general assumptions, no soil blending is required to dispose contaminated soil at ERDF.

Fluor Hanford Oversight: As indicated in the general assumptions, Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization).

- Duration of construction oversight = 1,059 days
- Construction oversight rate = \$215/hour or \$1,720/day.

During decontamination activities Fluor Hanford will provide four RCTs to scan materials and equipment leaving the site.

- RCTs (4 at decon pad) = \$56/hour x 8 hours/day x 4 RCTs
  = \$1,792/day.

During all excavation activities on site Fluor Hanford will provide one RCT per excavator to scan the soil coming from the excavation to determine if the soil is considered overburden or contaminated.

- RCT (1 per on site excavator) = \$56/hour x 8 hours/day
  = \$448/day.

Fluor Hanford Sampling: Soil samples and air samples will be collected throughout the duration of construction. The frequency of each type of sample is described below.

Soil Sampling: Soil samples will be collected during the excavation of overburden soil and contaminated soil. The rate at which these samples will be collected equals six samples per site within the overburden soil, and one sample for every 845 yd^3 of excavated contaminated soil (bulked by 15%). These samples will be analyzed in an on site laboratory. Quality control samples will be sent to an off site laboratory at a rate of 1 for every 20 samples collected (5% of samples collected) or a minimum of one per site. Labor to collect soil samples includes one sample technician (half time) and one RCT (full time).

- Number of overburden samples = 6 samples
- Cost per sample (on site lab) = \$1,100 / sample
- Cost per sample (off site lab) = \$5,000 / sample
- Volume of contaminated soil + 15% = 629,031 yd^3 + 15%
- Number of contaminated soil samples = 723,385 yd^3 / 845 yd^3
  = 856 samples
- Cost per sample (on site lab) = \$5,000 / sample
- Cost per sample (off site lab) = \$5,000 / sample
- Labor (sample tech) = \$56/hour x 8 hours/day x ½ time
  = \$224/day
- Labor (RCT) = (\$56/hour) x (8 hours/day)
  = \$448/day
- Labor (total) = \$672/day
- Days of sampling = 638 days (days of excavation).

Air Sampling: Air samples will be collected during excavation activities, placement of first layer of backfill material, and dynamic compaction. The rate at which air samples will be collected equals one air sample per day in which the above referenced activities are taking place. Each sample collected will cost \$1,000 to analyze plus labor to collect the samples and \$500 per sample in sampling equipment. Labor to collect air samples includes one sample technician (full time) and one RCT (full time).

- Number of days for excavation = 638 days
- Number of days to backfill first layer = 188 days
- Number of days for dynamic compaction = 69 days
- Number of days = 895 days
- Number of air samples collected = 895 samples
- Labor (one sample tech and one RCT) = (\$56/hour) x (8 hours/day) x 2
  = \$896/day.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions for Alternative 3, the cost for transportation and disposal of contaminated material at the ERDF is \$1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. ERDF storage cost is obtained from DOE/EM-0387 "Profiles of Environmental Restoration CERCLA Disposal Facilities", July 1999. The number of containers for disposal is calculated as follows:

- Volume of contaminated soil = 629,031 yd^3 (see Site Description)
- Number of containers = 629,031 yd^3 x 1 container/11 yd^3
  = 57,185 containers.

Mobilization/Demobilization: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operation costs of a generator (site utilities on cost table) during the construction period. Field office support consists of trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - Two bulldozers with tiller attachments and two operators
  - Two front-end loaders and two operators
  - One vibratory roller and one operator
  - One water truck and one driver
  - One office trailer
  - One storage trailer
  - Four laborers
- On-site borrow source
  - Two hydraulic excavators and two operators

- Two front-end loaders and one operators
- Ten dump trucks and ten drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows

- Mobilization and demobilization = (1 mob + 1 demob) x 8 hours/day x \$37/hour = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction surveys is based on the following:

- Area of construction survey = Area of disturbance + 20%
  = (1,188 ft x 1,188 ft) x 1.2
  = (1,693,613 ft^2) / (43,560 ft^2/acre)
  = 38.9 acres
- Cost to perform survey = \$1,784/acre/survey.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

- Length of temporary fence = 2 x (width + length) + 20%
  = 2 x (1,188 ft + 1,188 ft) x 1.2
  = 5,702 ft.

A haul road is assumed to be installed from the main road to the site. The haul road will consist of 6 inches of 1.5 inch gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = [(24 ft x 1,500 ft) + 10%] = 39,600 ft^2 = 4,400 yd^2
- Cost when place at 6-in = \$7.36/yd^2.

Decontamination: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad constructed for Alternative 5 is the same pad discussed in Alternative 3. Refer to Alternative 3 for decontamination pad descriptions.

The rate of decontamination water usage is assumed to be 1,000 gallon/month. The time that the decontamination pad is in use (during excavation of contaminated soils) equals 572 days.

- Decontamination water = (1,000 gal/month)(1 month/21 days)(572 days)
  = 27,238 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of contaminated soil excavation = 572 days
- Labor rates (4 laborers) = \$37/hour/laborer x 4 laborers
  = \$148/hour x 8 hours/day
  = \$1,184/day.

Due to the duration of the project the decontamination pad will be replaced once every 36 months.

Excavation: The overburden excavation will be performed using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing non-contaminated soil and placing it on the ground next to the excavation. A front-end loader will be used to move the soil to a nearby stock pile. Due to screening requirements (radiation screening of excavated soil), one excavator is expected to proceed at a rate of 120 yd^3/hour or 960 yd^3/day for overburden soil (1,920 yd^3/day for two excavators). It is assumed that the overburden stockpile can be placed close enough to the excavation to allow the production rate of the front-end loader to meet or exceed that of the excavator. Labor for overburden excavation consists of four operators (two for the excavators and two for the front-end loaders) and two RCT to screen the excavated soil.

- Volume of overburden soil = 125,912 yd^3
- Days to excavate overburden soil = 125,912 yd^3 / 1,920 yd^3/day
  = 66 days
- Labor (4 operators) = \$37/hour x 8 hours/day/person
  = \$296/day/person.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator can excavate the contaminated material and load it directly into the disposal containers mounted on the trucks. It is assumed that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to the ERDF daily (as indicated in the general assumptions, no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3/day. Labor for contaminated soil excavation consists of two operators (for the excavators), two RCT with (one per excavator) to screen the excavated soil, four laborers to perform decontamination activities, and four RCTs to screen decontaminated containers and trucks. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 629,031 yd^3
- Days to excavate contaminated soil = 629,031 yd^3 / 1,100 yd^3/day
  = 572 days
- Labor (4 laborers & 2 operators) = \$37/hour x 8 hours/day/person
  = \$296/day/person.

During all excavation activities it is required to have a water truck in operation. The costs associated with the water truck include the truck and one driver.

- Days required for excavation = 66 days + 572 days = 638 days
- Labor (one driver) = \$37/hour x 8 hours/day = \$296/day.

Site Restoration: Site restoration will consist of backfilling the excavation to within 40 inches of final grade with fill soil (consists of clean overburden soil previously excavated and fill materials obtained from the local borrow pit), constructing cap layers, and revegetation. Once the initial ten feet of fill soil is placed into the excavation using two front-end loaders and two bulldozers, the material will be dynamically compacted. Following dynamic compaction, fill soil will be placed to the desired depth (final grade minus 40 inches) using the front-end loaders, the bulldozers, and a vibratory roller for compaction. Following the placement of the fill soil, cap soils will be placed to final grade. Cap soils consist of 20 inches of compacted silt loam (obtained from the on-site borrow source) and 20 inches of a silt loam pea gravel mixture (silt loam obtained from the on-site borrow source and pea gravel purchased). The compacted silt loam layer will be placed using the front-end loaders, the bulldozers, and a vibratory roller. The silt loam pea gravel layer will be placed with the front-end loaders and the bulldozers using the tiller attachments (no compaction required).

Based on the information provided under Site Description, backfill volumes are as follows:

- Total backfill volume = 754,943 yd^3
- Available overburden material = 125,912 yd^3
- Required volume to be compacted dynamically = 496,737 yd^3
- Required volume of silt loam (on-site borrow source) = 85,428 yd^3

  [This layer will be compacted while placing. The value equals the total required backfill volume (754,943 yd^3) minus the volume in the cap layers (8,675 yd^3 + 78,079 yd^3 + 86,024 yd^3) minus the initial ten foot backfill volume (496,737 yd^3)]
- Required volume bottom cap layer (on-site borrow source) (to be compacted while placing) = 86,024 yd^3
- Required volume top cap layer (on-site borrow source) (no compaction) = 78,079 yd^3
- Required volume top cap layer (pea gravel) (no compaction) = 8,675 yd^3.

Backfilling First 10 feet: The following material volume is required to backfill the first 10 feet of excavation.

- Required volume to achieve first 10 feet = 496,737 yd^3
- Available overburden soil = 125,912 yd^3
- On-site borrow source material needed = 370,825 yd^3.

Backfilling First 10 feet (overburden soil): To avoid contact with the contaminated soil left in place, ten feet of fill soil (overburden and/or on-site borrow source material) will be placed on top of the remaining contaminated soil. Prior to using offsite soils, overburden soil will be backfilled using two front-end loaders and two bulldozers. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour (for each loader and dozer). Operating two loaders and two dozers for 8 hours/day, the production rate is 2,960 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 125,912 yd^3 (see Site Description)
- Days to backfill overburden soil = 125,912 yd^3 / 2,960 yd^3/day = 43 days
- Labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.

Backfilling First 10 feet (on-site borrow source material): Following placement of the available overburden soil, the on-site borrow source material will be used to achieve the first 10 feet of backfill. Backfilling the on-site borrow source material will be performed using two hydraulic excavators at the on-site borrow source, two front-end loaders at the on-site borrow source, ten trucks to transport the on-site borrow source material to the site, two front-end loaders on site, and two bulldozers on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (320 yd^3/hour or 2,560 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 370,825 yd^3 (see Site Description)
- Days to backfill on-site borrow source material = 370,825 yd^3 / 2,560 yd^3/day = 145 days
- On-site borrow source labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- On site labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- Labor (each truck) = \$37/hour x 8 hours/day = \$296/day + truck rental.

Dynamic Compaction: To avoid contact with the contaminated soil left in place, ten feet of fill soil (overburden and/or on-site borrow source material) will be placed on top of the remaining contaminated soil. This material will then be dynamically compacted using a crane with a large weight. To achieve compaction, the crane will drop the weight onto the backfill material. The assumed production rate is 5,000 ft^2/day (see Alternative 4 text for increased production rates on larger areas). Labor for dynamic compaction includes one operator and one oiler.

- Area requiring dynamic compaction (Area 10 feet up from bottom of excavation) = 1,375,929 ft^2
- Compaction rate = 5,000 ft^2/day
- Compaction rate (4 compactors) = 20,000 ft^2/day
- Days to perform dynamic compaction = 69 days
- Labor (4 operators and 4 oilers) = \$37/hour x 8 hour/day x 2 people = \$592/day.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 70 days.

<u>Backfill Subgrade Soil (on-site borrow source material)</u>: Following dynamic compaction, on-site borrow source material will be used to achieve final grades minus the 40 inches of cap materials. Backfilling the on-site borrow source material will be performed using two hydraulic excavators at the on-site borrow source, two front-end loaders at the on-site borrow source, ten trucks to transport the on-site borrow source material to the site, two front-end loaders on site, two bulldozers on site and one vibratory roller on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on ten trucks carrying 16 yd^3 each, making two trips an hour (320 yd^3/hour or 2,560 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- On-site borrow source material backfill volume = 85,428 yd^3 (see Site Description)
- Days to backfill on-site borrow source material = 85,428 yd^3 / 2,560 yd^3/day = 34 days
- On-site borrow source labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- On site labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.
- Labor (each truck) = \$37/hour x 8 hours/day = \$296/day + truck rental.

<u>Backfilling Compacted Silt Loam (Bottom Cap Layer)</u>: Compacted silt loam can be obtained from the on-site borrow source and must be trucked to the site. Therefore, using the same equipment used for the Subgrade soil, it is assumed that the compacted silt loam from the on-site borrow source can be backfilled at a rate of 320 yd^3/hour. Operating the equipment for 8 hours each day, the production rate equals 2,560 yd^3/day. Labor for backfilling the on-site borrow source silt loam includes operators for each piece of equipment and ten drivers for the trucks.

- Compacted silt loam (on-site borrow source) = 86,024 yd^3
- Days to place compacted silt loam = 86,024 yd^3 / 2,560 yd^3/day

= 34 days

- Labor (10 operators and 10 drivers) = \$37/hour x 8 hours/day/person
  = \$296/day/person.

Backfilling Silt Loam and Pea Gravel (Top Cap Layer): The silt loam for this layer can be obtained from the on-site borrow source. Like the fill soil, on-site borrow source silt loam needs to be trucked to the site. Therefore, using the same equipment used for the bottom cap layer, it is assumed that the silt loam from the on-site borrow source can be backfilled at a rate equal to 320 yd^3/hour. Operating the equipment for 8 hours each day, the production rate equals 2,560 yd^3/day. The pea gravel for this layer must be purchased off-site and will need to be delivered to the site. It is assumed that the pea gravel can be delivered to the site, and placed in the excavation at a rate of 2,560 yd^3/day. The pea gravel and silt loam will be mixed within the excavation by placing thin layers of each material and using the tiller attachment on the bulldozers as the pea gravel is placed. Labor for backfilling silt loam and pea gravel includes operators for each piece of equipment, and ten drivers for the trucks.

- Silt loam (on-site borrow source) = 78,079 yd^3
- Pea gravel (purchased) = 8,675 yd^3
- Total volume to backfill = 86,754 yd^3
- Days to place silt loam/pea gravel = (86,754 yd^3) / (2,560 yd^3/day)
  = 34 days
- On-site borrow source labor (4 op. and 10 drivers) = \$37/hour x 8 hours/day x 7 people
  = \$2,072/day
- On site labor (4 operators) = \$37/hour x 8 hours/day x 2 people
  = \$592/day.

Revegetation: Following the installation of the cap the silt loam with pea gravel will be revegetated. Revegetation costs are based on the following;

- Area to be revegetated = 1,411,344 ft^2 + 20%
  = 188,179 yd^2
- Revegetation (includes lime, fertilizer, and seed) = \$1.63/yd^2
- Production rate (4 crews) = 4,000 yd^2/day = 47 days.

During all restoration activities (backfilling, compaction, and revegetation) it is required to have a water truck in operation. The costs associated with the water truck include the truck and one driver.

- Days required for restoration = 43 + 145 + 69 + 34 + 34 + 34 + 47 days
  = 406 days
- Labor (one driver) = \$37/hour x 8 hours/day
  = \$296/day.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

- Duration of contractor support = 1,059 days
- Contractor support rate = \$237/hour = \$1,896/day (see general assumptions)
- Time to prepare post-construction documents = 160 hours (assumption)
- Labor rate for post-construction documents = \$50/hour (assumption).

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The surveillance and cap maintenance is expected to be equal to the site inspection/surveillance and existing cover maintenance cost items under Alternative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cover system = 1,411,344 ft^2
  - Number of two-hour increments = 1,411,344 ft^2 / 12,500 ft^2 = 113
  - Team hours to complete inspections = 28.25 days (2 hours for every 12,500 ft^2)
  - Hourly inspection rate (2 people) = \$112/hour (\$56/hour/person)
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$282,000/event
- Cover maintenance (footprint of cover system)
  - Area of cover system (including berm) = 1,411,344 ft^2
  - Area requiring repair (10% of total area) = 141,134 ft^2 = 15,681 yd^2
  - Volume of surface layer to replace = 8,712 yd^3 (20 inches of silt loam and pea gravel over 10% of area)
  - Oversight (soil placement 160 yd^3/hour) = 7 days
  - Oversight (vegetation 2,000 yd^2/day) = 8 days (2 crews)

Oversight performed by one Fluor Hanford Engineer at \$56/hour or \$448/day.

Monitoring. Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. Refer to Section D3.1.4.

D3.5.3 Representative Site 216-U-14 Ditch

Representative Site 216-U-14 is not evaluated for Alternative 5. Refer to General Assumptions, Section 3.5.1.

D3.5.4 Representative Site 216-Z-11 Ditch

Representative Site 216-Z-11 is not evaluated for Alternative 5. Refer to General Assumptions, Section 3.5.1.

D3.5.5 Representative Site 216-A-25 Gable Mountain Pond

Representative Site 216-A-25 is not evaluated for Alternative 5. Refer to General Assumptions, Section 3.5.1.

D3.5.6 Representative Site 216-T-26 Crib (Cost tables D-55 through D-58)

This site work was estimated to take 6.2 weeks (1.5 months) based on the following breakdown. Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days (2 weeks), includes mobilizing equipment and personnel, installing and construction temporary facilities, performing the site survey, and performing decontamination setup.
- Excavate/dispose: 6 days (1.2 weeks)
- Restore/Cap: 10 days (2 weeks) (includes revegetation)
- Demobilize: 5 days (1 week), includes demobilizing facilities, equipment, and personnel, performing the as-built site survey, and performing final site cleanup.

The total construction duration = 31 days = 6.2 weeks = 1.5 months.

Site Description: The following information can be found in Table D-64 or on the table presented under general assumptions.

- Area of contaminant mass = 30 ft x 30 ft = 900 ft^2
- Depth of overburden soil = 18 ft bgs (see assumptions)
- Total depth of excavation = 30 ft bgs (see assumptions)
- Area of disturbance = 120 ft x 120 ft = 14,400 ft^2.

The following volumes have been calculated using the site information. This information and quantities used to generate this information is also provided in Table D-64.

- Total excavation volume (based on 1.5H:1V side slopes) = 8,500 yd^3
- Depth of contaminated soil (30 ft – 18 ft) = 12 ft
- Volume of contaminated soil = 400 yd^3
- Volume of overburden soil = 8,100 yd^3
- Volume of material to ERDF = 400 yd^3
- Overburden available for backfill = 8,100 yd^3

- Total backfill volume required = 8,500 yd^3
- Total offsite fill needed (cap material) = 1,635 yd^3

  [surface area times thickness of cap with side slopes equal to 1.5H:1V equals ((14,400 ft^2 + 12,100 ft^2) / 2) x (40 inches / 12 inches/foot) / 27 ft^3/yd^3)]
- Cap materials (top layer 20 inches thick) = 853 yd^3
  - Pea gravel (10% of volume) = 86 yd^3
  - Silt loam (on-site borrow source material) = 767 yd^3
- Cap material (bottom layer 20 inches thick) = 782 yd^3
  - Silt loam (on-site borrow source material) = 782 yd^3
- Subgrade soil (on-site borrow source material) = 6,864 yd^3

  [equals total backfill (8,500 yd^3) minus cap volumes (1,636 yd^3)]

As indicated in the general assumptions, no soil blending is required to dispose contaminated soil at ERDF.

Fluor Hanford Oversight: As indicated in the general assumptions, Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization).

- Duration of construction oversight = 31 days
- Construction oversight rate = \$215/hour or \$1,720/day.

During decontamination activities Fluor Hanford will provide four RCTs to scan materials and equipment leaving the site.

- RCTs (4 at decon pad) = \$56/hour x 8 hours/day x 4 RCTs

  = \$1,792/day.

During all excavation activities on site Fluor Hanford will provide one RCT per excavator to scan the soil coming from the excavation to determine if the soil is considered overburden or contaminated.

- RCT (1 per on site excavator) = \$56/hour x 8 hours/day

  = \$448/day.

Fluor Hanford Sampling: Soil samples and air samples will be collected throughout the duration of construction. The frequency of each type of sample is described below.

<u>Soil Sampling</u>: Soil samples will be collected during the excavation of overburden soil and contaminated soil. The rate at which these samples will be collected equals six samples per site within the overburden soil, and one sample for every 845 yd^3 of excavated contaminated soil (bulked by 15%). These samples will be analyzed in an on site laboratory. Quality control samples will be sent to an off site laboratory at a rate of 1 for every 20 samples collected (5% of samples collected) or a minimum of one per site. Labor to collect soil samples includes one sample technician (half time) and one RCT (full time).

- Number of overburden samples = 6 samples

- Cost per sample (on site lab) = $1,100 / sample
- Cost per sample (off site lab) = $5,000 / sample
- Volume of contaminated soil + 15% = 400 yd^3 + 15%
- Number of contaminated soil samples = 460 yd^3 / 845 yd^3
  (6 samples minimum) = 6 samples
- Cost per sample (on site lab) = $5,000 / sample
- Cost per sample (off site lab) = $5,000 / sample
- Labor (sample tech) = $56/hour x 8 hours/day x ½ time
  = $224/day
- Labor (RCT) = ($56/hour) x (8 hours/day)
  = $448/day
- Labor (total) = $672/day
- Days of sampling = 6 days (days of excavation).

Air Sampling: Air samples will be collected during excavation activities, placement of first layer of backfill material, and dynamic compaction. The rate at which air samples will be collected equals one air sample per day in which the above referenced activities are taking place. Each sample collected will cost $1,000 to analyze plus labor to collect the samples and $500 per sample in sampling equipment. Labor to collect air samples includes one sample technician (full time) and one RCT (full time).

- Number of days for excavation = 6 days
- Number of days to backfill first layer = 1 days
- Number of days for dynamic compaction = 1 days
- Number of days = 8 days
- Number of air samples collected = 8 samples
- Labor (one sample tech and one RCT) = ($56/hour) x (8 hours/day) x 2
  = $896/day.

Fluor Hanford Transportation and Disposal: As mentioned in the general assumptions for Alternative 3, the cost for transportation and disposal of contaminated material at the ERDF is $1,100 per container. This cost includes labor cost to install the liners, material cost for the liners, transportation to the ERDF, and ERDF storage costs. ERDF storage cost is obtained from DOE/EM-0387 "Profiles of Environmental Restoration CERCLA Disposal Facilities", July 1999. The number of containers for disposal is calculated as follows:

- Volume of contaminated soil = 400 yd^3 (see Site Description)
- Number of containers = 400 yd^3 x 1 container/11 yd^3
  = 37 containers.

Mobilization/Demobilization: During the implementation of the RA, an office trailer and storage trailer are assumed to be rented as part of the office trailer and storage trailer cost. Other costs under field support are field office support and the mobilization, demobilization, monthly rental, and operation costs of a generator (site utilities on cost table) during the construction period. Field office support consists of trailer amenities (a computer, a printer/copier/scanner, paper, etc.).

Mobilization and demobilization of the following pieces of equipment and personnel will be included in the cost:

- Site
  - Two hydraulic excavators and two operators
  - One bulldozer with tiller attachment and one operator
  - One front-end loader and one operator
  - One vibratory roller and one operator
  - One water truck and one driver
  - One office trailer
  - One storage trailer
  - Four laborers
- On-site borrow source
  - One hydraulic excavator and one operator
  - One front-end loader and one operator
  - Five dump trucks and five drivers.

Mobilization and demobilization for personnel has been assumed. The cost is calculated as follows

- Mobilization and demobilization = (1 mob + 1 demob) x 8 hours/day x \$37/hour
  = \$592/person.

It is assumed that a topographical construction survey will be performed before disturbing the site and after site restoration. The cost for a single construction surveys is based on the following:

- Area of construction survey = Area of disturbance + 20%
  = (120 ft x 120 ft) x 1.2
  = (17,280 ft^2) / (43,560 ft^2/acre)
  = 0.4 acres
- Cost to perform survey = \$1,784/acre/survey.

Temporary blaze orange fence will be placed around the site for protection from the excavation area. The cost of the temporary fence is based on the following:

- Length of temporary fence = 2 x (width + length) + 20%
  = 2 x (120 ft + 120 ft) x 1.2
  = 576 ft.

A haul road is assumed to be installed from the main road to the site. The haul road will consist of 6 inches of 1.5 inch gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = [(24 ft x 1,500 ft) + 10%] = 39,600 ft^2 = 4,400 yd^2
- Cost when place at 6-in = \$7.36/yd^2.

Decontamination: A decontamination pad will be constructed to clean trucks and containers before leaving the site and equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad constructed for Alternative 5 is the same pad discussed in Alternative 3. Refer to Alternative 3 for decontamination pad descriptions.

The rate of decontamination water usage is assumed to be 1,000 gallon/month. The time that the decontamination pad is in use (during excavation of contaminated soils) equals 1 day.

- Decontamination water = (1,000 gal/month)(1 month/21 days)(1 day)
  = 48 gal.

The decontamination pad will be staffed for the duration of contaminated soil excavation. It is assumed that the decontamination crew will consist of four laborers.

- Duration of Contaminated soil excavation = 1 day
- Labor rates (4 laborers) = \$37/hour/laborer x 4 laborers
  = \$148/hour x 8 hours/day
  = \$1,184/day.

Excavation: The overburden excavation will be performed using two hydraulic excavators and one front-end loader. Overburden soil will be excavated by removing non-contaminated soil and placing it on the ground next to the excavation. A front-end loader will be used to move the soil to a nearby stock pile. Due to screening requirements (radiation screening of excavated soil), one excavator is expected to proceed at a rate of 120 yd^3/hour or 960 yd^3/day for overburden soil (1,920 yd^3/day for two excavators). It is assumed that the overburden stockpile can be placed close enough to the excavation to allow the production rate of the front-end loader to meet or exceed that of the excavator. Labor for overburden excavation consists of four operators (two for the excavators and two for the front-end loaders) and two RCT to screen the excavated soil.

- Volume of overburden soil = 8,100 yd^3
- Days to excavate overburden soil = 8,100 yd^3 / 1,920 yd^3/day
  = 5 days
- Labor (4 operators) = \$37/hour x 8 hours/day/person
  = \$296/day/person.

Contaminated soil will be excavated using two hydraulic excavators. Trucks are expected to have access to the excavation area such that the hydraulic excavator can excavate the contaminated material and load it directly into the disposal containers mounted on the trucks. It is assumed that 100 containers can be sent to the ERDF on a daily basis. With 11 yd^3 of material per container, a total of 1,100 yd^3 of material will be sent to the ERDF daily (as indicated in the general assumptions, no blending is required). Therefore, the duration of contaminated soil excavation is determined by dividing the total volume of contaminated soil by 1,100 yd^3/day. Labor for contaminated soil excavation consists of two operators (for the excavators), two RCT with (one per excavator) to screen the excavated soil, four laborers to perform decontamination activities, and four RCTs to screen decontaminated containers and trucks. The cost for excavating and loading contaminated soil is based on the following:

- Volume of contaminated soil = 400 yd^3
- Days to excavate contaminated soil = 400 yd^3 / 1,100 yd^3/day
  = 1 day
- Labor (4 laborers & 2 operators) = \$37/hour x 8 hours/day/person
  = \$296/day/person.

During all excavation activities it is required to have a water truck in operation. The costs associated with the water truck include the truck and one driver.

- Days required for excavation = 5 days + 1 day = 6 days
- Labor (one driver) = \$37/hour x 8 hours/day
  = \$296/day.

Site Restoration: Site restoration will consist of backfilling the excavation to within 40 inches of final grade with fill soil (consists of clean overburden soil previously excavated and fill materials obtained from the local borrow pit), constructing cap layers, and revegetation. Once the initial ten feet of fill soil is placed into the excavation using one front-end loader and one bulldozer, the material will be dynamically compacted. Following dynamic compaction, fill soil will be placed to the desired depth (final grade minus 40 inches) using the front-end loader, the bulldozer, and a vibratory roller for compaction. Following the placement of the fill soil, cap soils will be placed to final grade. Cap soils consist of 20 inches of compacted silt loam (obtained from the on-site borrow source) and 20 inches of a silt loam pea gravel mixture (silt loam obtained from the on-site borrow source and pea gravel purchased). The compacted silt loam layer will be placed using the front-end loader, the bulldozer, and a vibratory roller. The silt loam pea gravel layer will be placed with the front-end loader and the bulldozer using the tiller attachment (no compaction required).

Based on the information provided under Site Description, backfill volumes are as follows:

- Total backfill volume = 8,500 yd^3
- Available overburden material = 8,100 yd^3
- Required volume to be compacted dynamically = 833 yd^3
- Required volume of overburden = 6,032 yd^3

  [This layer will be compacted while placing. The value equals the total required backfill volume (8,500 yd^3) minus the volume in the cap layers (86 yd^3 + 767 yd^3 + 782 yd^3) minus the initial ten foot backfill volume (833 yd^3)]

(to be compacted while placing)

- Required volume bottom cap layer = 782 yd^3 (on-site borrow source) (to be compacted while placing)
- Required volume top cap layer = 767 yd^3 (on-site borrow source) (no compaction)
- Required volume top cap layer (pea gravel) = 86 yd^3. (no compaction)

Since the overburden backfill (6,032 + 833) 6,865 yd^3 is less than the available 8,100 yd^3 of overburden, 1,235 yd^3 of overburden will remain stockpiled on site following restoration.

Backfilling First 10 feet: The following material volume is required to backfill the first 10 feet of excavation.

- Required volume to achieve first 10 feet = 833 yd^3
- Available overburden soil = 8,100 yd^3
- On-site borrow source material needed = 0 yd^3.

Backfilling First 10 feet (overburden soil): To avoid contact with the contaminated soil left in place, ten feet of fill soil (overburden and/or on-site borrow source material) will be placed on top of the remaining contaminated soil. Prior to using offsite soils, overburden soil will be backfilled using one front-end loader and one bulldozer. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour or 1,480 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Volume of overburden to backfill = 833 yd^3 (see Site Description)
- Days to backfill overburden soil = 833 yd^3 / 1,480 yd^3/day = 1 day
- Labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.

Dynamic Compaction: To avoid contact with the contaminated soil left in place, ten feet of fill soil (overburden and/or on-site borrow source material) will be placed on top of the remaining contaminated soil. This material will then be dynamically compacted using a crane with a large weight. To achieve compaction, the crane will drop the weight onto the backfill material. The assumed production rate is 5,000 ft^2/day. Labor for dynamic compaction includes one operator and one oiler.

- Area requiring dynamic compaction = 3,600 ft^2 (Area 10 feet up from bottom of excavation)
- Compaction rate = 5,000 ft^2/day

- Days to perform dynamic compaction = 1 day
- Labor (1 operators and 1 oilers) = \$37/hour x 8 hour/day x 2 people = \$592/day.

Allowing 1 day for decontamination, the dynamic compactors, operators and oilers are required on site for 2 days.

Backfill Subgrade Soil (Overburden): Following dynamic compaction, overburden will be used to achieve final grades minus the 40 inches of cap materials. Overburden soil will be backfilled using one front-end loader and one bulldozer. It is assumed that the overburden soil can be backfilled at a rate of 185 yd^3/hour or 1,480 yd^3/day. Labor for overburden soil backfill consists of equipment operators for each piece of equipment. The cost associated with overburden soil backfill is based on the following:

- Overburden backfill volume = 6,032 yd^3 (see Site Description)
- Days to backfill overburden = 6,032 yd^3 / 1,480 yd^3/day = 4 days
- On site labor (each machine) = \$37/hour x 8 hours/day = \$296/day + equipment rental.

Backfilling Compacted Silt Loam (Bottom Cap Layer): Compacted silt loam can be obtained from the on-site borrow source and must be trucked to the site. Backfilling the on-site borrow source material will be performed using one hydraulic excavator at the on-site borrow source, one front-end loader at the on-site borrow source, five trucks to transport the on-site borrow source material to the site, one front-end loader on site, one bulldozer on site and one vibratory roller on site. It is assumed that the production rate for backfilling with the on-site borrow source material equals the rate that soil can be transported to the site from the on-site borrow source. The transportation rate is based on five trucks carrying 16 yd^3 each, making two trips an hour (160 yd^3/hour or 1,280 yd^3/day). The cost associated with the on-site borrow source soil backfill is based on the following:

- Compacted silt loam (on-site borrow source) = 782 yd^3
- Days to place compacted silt loam = 782 yd^3 / 1,280 yd^3/day = 1 day
- On-site borrow source labor (2 op. and 5 drivers) = \$37/hour x 8 hours/day x 7 people = \$2,072/day
- On site labor (3 operators) = \$37/hour x 8 hours/day x 3 people = \$888/day.

Backfilling Silt Loam and Pea Gravel (Top Cap Layer): The silt loam for this layer can be obtained from the on-site borrow source. Like the fill soil, the on-site borrow source silt loam needs to be trucked to the site. Therefore, using the same equipment used for the bottom cap layer, it is assumed that the silt loam from the on-site borrow source can be backfilled at a rate equal to 160 yd^3/hour. Operating the equipment for 8 hours each day, the production rate equals

1,280 yd^3/day. The pea gravel for this layer must be purchased off-site and will need to be delivered to the site. It is assumed that the pea gravel can be delivered to the site, and placed in the excavation at a rate of 1,280 yd^3/day. The pea gravel and silt loam will be mixed within the excavation by placing thin layers of each material and using the tiller attachment on the bulldozers as the pea gravel is placed. Labor for backfilling silt loam and pea gravel includes operators for each piece of equipment, and ten drivers for the trucks.

- Silt loam (on-site borrow source) = 767 yd^3
- Pea gravel (purchased) = 86 yd^3
- Total volume to backfill = 853 yd^3
- Days to place silt loam/pea gravel = (853 yd^3) / (1,280 yd^3/day) = 1 day
- On-site borrow source labor (2 op. and 5 drivers) = \$37/hour x 8 hours/day x 7 people = \$2,072/day
- On site labor (3 operators) = \$37/hour x 8 hours/day x 3 people = \$888/day.

Revegetation: Following the installation of the cap the silt loam with pea gravel will be revegetated. Revegetation costs are based on the following;

- Area to be revegetated = 14,400 ft^2 + 20% = 1,920 yd^2
- Revegetation (includes lime, fertilizer, and seed) = \$1.63/yd^2
- Production rate (1 crew) = 1,000 yd^2/day = 2 days.

During all restoration activities (backfilling, compaction, and revegetation) it is required to have a water truck in operation. The costs associated with the water truck include the truck and one driver.

- Days required for restoration = 1 + 1 + 4 + 1 + 1 + 2 days = 10 days
- Labor (one driver) = \$37/hour x 8 hours/day = \$296/day.

Miscellaneous: Miscellaneous costs for this cost estimate consist of support personnel and preparing post-construction documents. During construction activities (mobilization through demobilization), the contractor will have support personnel on site. Miscellaneous costs are calculated as follows:

- Duration of contractor support = 31 days
- Contractor support rate = \$237/hour = \$1,896/day (see general assumptions)
- Time to prepare post-construction documents = 160 hours (assumption)

- Labor rate for post-construction documents = \$50/hour (assumption).

Surveillance and Cap Maintenance: The costs associated with surveillance and cap maintenance are operation and maintenance costs and are incurred annually. The surveillance and cap maintenance is expected to be equal to the site inspection/surveillance and existing cover maintenance cost items under Alternative 2. Refer to the Alternative 2 assumptions for these cost items. The surveillance and cap maintenance costs are calculated as follows:

- Surveillance/inspections (footprint of cap system)
  - Area of cover system = 14,400 ft^2
  - Number of two-hour increments = 14,400 ft^2 / 12,500 ft^2 = 2
  - Team hours to complete inspections = 0.5 day (2 hours for every 12,500 ft^2)
  - Hourly inspection rate (2 people) = \$112/hour (\$56/hour/person)
  - Radiation surveys of surface soil = \$1,000 for every 5,000 ft^2 = \$3,000/event
- Cover maintenance (footprint of cover system)
  - Area of cover system (including berm) = 14,400 ft^2
  - Area requiring repair (10% of total area) = 1,440 ft^2 = 160 yd^2
  - Volume of surface layer to replace = 89 yd^3 (20 inches of silt loam and pea gravel over 10% of area)
  - Oversight (soil placement 160 yd^3/hour) = 1 days
  - Oversight (vegetation 1,000 yd^2/day) = 1 days (1 crews)

Oversight performed by one Fluor Hanford Engineer at \$56/hour or \$448/day.

Monitoring. Monitoring includes collecting groundwater samples from down-gradient wells to evaluate the performance of the cap system. As indicated in the general assumptions, these monitoring costs are institutional costs and are not included in this cost estimate.

D3.6 ALTERNATIVE 6 – IN SITU VITRIFICATION

D3.6.1 General Assumptions

The general assumptions for Alternative 6 are as follows:

- Two contractors will be employed under this alternative. One contractor will provide infrastructure needed for the project as well as perform site restoration. Specific tasks include:
  - Conducting the pre-construction site survey.
  - Installing the temporary fence around the site.

- Installing the haul road.
- Constructing, staffing, and removing the decontamination pad and providing decontamination water.
- Fine grading and seeding the site.

The second contractor will be hired to conduct in situ vitrification on contaminated soil at the site to a depth of 15 ft bgs.

- Fluor Hanford will provide construction oversight and site amenities such as the office trailer, field office support, and the storage trailer. Personnel used to perform construction oversight include a project manager, a RCT, a health and safety manager (half time), and a QA/QC representative and scheduler. This oversight crew will be used whenever the contractors are in operation. Using the wages discussed in Section D3.1, this crew has an hourly rate of $215 ($1,720 daily rate).

- Periodic groundwater monitoring costs will be added to Table D-65 as indicated in Section D3.1.4.

- The prices that make up the cost estimate were obtained from one of the following sources:

  - *Site Work and Landscape Cost Data*, 23rd Annual Edition (Means, 2004b).

  - *Mixed Waste Treatment and Cost Analyses for a Range of GeoMelt Vitrification Process Configurations*, LE Thompson, AMEC Earth and Environmental, Inc.

  - *IM Completion Report for the NTISV Hot Demonstration at SWMU 21-018(a)-99 (MDA V)*, Los Alamos National Laboratory, September 2003.

  - Experience on similar projects.

D3.6.2 Representative Site 216-Z-11 Ditch (Cost tables D-59 through D-62)

The site work was estimated to take 169.6 weeks (39.6 months) based on the following breakdown. It should be noted that the in situ vitrification process is operable 24 hours a day, 7 days a week, 290 days per year (80%). Time required for preparing pre- and post-construction submittals is in addition to the times estimated here.

- Mobilize: 10 days, 8 hours a day, 5 days a week, and 21 days a month (2 weeks and 0.5 months), includes mobilizing equipment and personnel, installing and constructing temporary facilities, performing the site survey, and performing decontamination setup.

- In situ vitrification: 1,144 days, 24 hours a day, 7 days a week, and 30 days a month (163.4 weeks, and 38.1 months).

- Site restoration: 11 days, 8 hours a day, 5 days a week, and 21 days a month (2.2 weeks and 0.5 months).

- Demobilize: 10 days, 8 hours a day, 5 days a week, and 21 days a month (2 weeks and 0.5 months), includes demobilizing facilities, equipment, and personnel and performing final site cleanup.

Total construction duration = 1,175 days = 169.6 weeks = 39.6 months.

Site Description: The basis for the following information can be found on Table D-63.

- Area of contaminant mass = (2,765 ft x 24 ft) + (1,635 ft x 4 ft)
- Area of in situ vitrification = (2,765 ft x 24 ft) + (1,635 ft x 8 ft) = 79,440 ft^2
- Total vitrification depth = 15 ft bgs
- Volume of contaminated soil = [(2,765 ft x 24 ft) + (1,635 ft x 8 ft)] x 15 ft = 1,191,600 ft^3 = 44,133 yd^3
- Soil density = 120 lb/ft^3
- Weight of contaminated soil = 1,191,600 ft^3 x 120 lb/ft^3 x 1 ton/2,000 lb = 71,496 tons
- Capacity of one vitrification melt = 500 tons
- Number of melts = 71,496 tons / 500 tons = 143 melts.

Fluor Hanford Oversight: Fluor Hanford will provide oversight for the duration of the construction activities (mobilization through demobilization). The cost of Fluor Hanford oversight is calculated as follows:

- Duration of construction oversight (Mob + demob + Restoration = 31 days
- Duration of construction oversight (Vitrification) = 1,144 days x 3 shifts = 3,432 days
- Total duration = 3,463 days
- Construction oversight rate = $1,720/day (see assumptions).

During decontamination activities Fluor Hanford will provide four RCTs to scan materials and equipment leaving the site.

- RCTs (4 at decon pad) = $56/hour x 8 hours/day x 4 RCTs = $1,792/day.

Fluor Hanford Site Amenities: Fluor Hanford will provide an office trailer, field office support, and a storage trailer during the project:

Mobilization, Demobilization, and Field Support: It is assumed that two topographical construction surveys will be performed, one before disturbing the site, and one following restoration activities. The cost for a single construction survey is based on the following:

Area of construction survey = area of vitrification + 20% = (2,765 ft x 24 ft) + (1,635 ft x 8 ft) + 20% = 2.2 acres. The cost for a single survey equals $1,748/acre.

Temporary blaze orange fence will be placed around the site for protection. The cost of the temporary fence is based on the following:

Length of temporary fence = 2 x (width + length) + 20% = 2 x [(2,765 ft + 24 ft) + (1,635 ft + 8 ft)] + 20% = 10,637 linear ft.

A haul road is assumed to be installed from a main road to the site. The haul road will consist of 6 in. of 1.5-in. gravel. The cost of the haul road is based on the following:

- Length of haul road = 1,500 ft
- Width of haul road = 24 ft
- Gravel = 24 ft x 1,500 ft + 10% = 39,600 ft^2 = 4,400 yd^2
- Cost when place at 6" = $7.36/ yd^2.

Decontamination Pad: A decontamination pad will be constructed to clean equipment before demobilization. It is assumed that all equipment can be decontaminated for reuse. The decontamination pad will be of a sufficient length and width to accommodate all proposed traffic to and from the site. The decontamination pad will consist of timber grates, plastic sheeting [60 mil linear low-density polyethylene (LLDPE)], PVC pipe, a sump with a pump and hoses, and two 1,000 gallon storage tanks. Labor to construct and remove the decontamination pad (four laborers) has been included in the decontamination pad cost. The spent decontamination water is assumed to be used for dust suppression on contaminated sites. A few of the decontamination pad components are as follows:

- Pad area = 20 ft x 30 ft
  = 600 ft^2
- Timber grates (2 in. x 4 in.) = (2 x 5 x 30 ft) + (2 x 17 x 3 ft)
  = 402 linear ft
  = 0.402 m board ft
- Plastic sheeting = (20 ft x 30 ft) + (2 x 8 ft overlap x 30 ft) + 10%
  = 1,188 ft^2
- 3-in. PVC pipe = 5 linear ft.

The amount of decontamination water is assumed to be 1,000 gal/month for the time decontamination is needed. It is assumed that decontamination activities will be needed for 2 days (1 month).

- Decontamination water = 1,000 gal/month x 1 month
  = 1,000 gal.

The decontamination pad will be staffed with four laborers.

- Duration of decontamination pad crew = 21 days
- Daily rate for four laborers = $1,792/day.

Site Restoration: Vegetation will be established following the in situ vitrification. It is expected that the area can be vegetated at a rate of 1,000 yd^2/day. Vegetation will be conducted while vitrification is occurring in other areas, if feasible, and during demobilization. Vegetation costs are based on the following:

- Area to receive vegetation (disturbance area + 20%) = (2,765 ft x 24 ft) + (1,635 ft x 8 ft) + 20% = 10,592 yd^2
- Vegetation (includes lime, fertilizer, and seed) = $1.63/$yd^2$ (Means, 2004b)
- Days to vegetate area = 10,592 yd^2 / 1,000 yd^2/day = 11 days.

A water truck will be rented for the duration of site restoration to aid in the growing of vegetation. Cost for a water truck is based on the following:

- Duration of vegetation = 11 days
- Labor (water truck driver) = $37/hour x 8 hours/day = $296/day + truck rental.

In Situ Vitrification: Using the information presented in the AMEC Earth and Environmental, Inc. reference, the estimated duration to perform the in situ vitrification is based on 7.5 days to perform a melt, and a 12 hour down time between melts. Therefore, running 24 hours a day, the time needed to perform in situ vitrification at 216-Z-11 is calculated as follows:

- Number of melts = 143 melts (see Site Description)
- Average time per melt = 7.5 days
- Total melt time = 143 melts x 7.5 days/melt = 1,072 days
- Downtime in between melts = 12 hours
- Total downtime = (143 – 1) x 12 hours x 1 day/24 hours 71 days
- Total time to perform in situ vitrification = 1,073 days + 71 days 1,144 days.

This duration is used for calculating the Fluor Hanford oversight costs.

The cost to perform in situ vitrification is based on the information presented in the Los Alamos National Laboratory reference. This document provides costing for in situ vitrification technology used at another Department of Energy Site. The document reports a total cost to perform in situ vitrification at $1,284,947 to treat 342 yd^3 of soil. The report breaks down the total costs into mobilization/demobilization and treatment. Mobilization and demobilization of the in situ vitrification subcontractor is reported to be one half the total project cost ($642,473), and treatment for 342 yd^3 is calculated from the remaining balance ($642,473 / 342 yd^3 = $1,878/$yd^3$. For purposes of calculating a cost for in-situ vitrification at 216-Z-11, the mobilization and demobilization costs will be assumed the same as provided in the reference report and the treatment costs are assumed to equal $1,878/$yd^3$. It is also assumed that the unit cost per cubic yard accounts for work plans and preparation reports, site preparation, site preconditioning, melting operations, hood moves, and required sampling and analysis. The following is a summary of the in-situ vitrification costs:

- Mobilization and Demobilization = $642,473
- Treatment = $1,878/$yd^3$

Annual and Periodic Costs: With in situ vitrification, annual inspections are required to verify that the remedy is providing the required protection. The annual inspections include a radiation survey of the surface soil plus a physical site inspection with associated reporting, and periodic groundwater monitoring. The periodic costs also include 5-year reviews. Refer to Alternative 2 (Section D3.2.2) for a description of these activities. The costs for site inspection and radiation survey are based on the following:

- Area of representative site = 79,440 ft^2 (see table D-63)
- Number of two-hour increments = 79,440 ft^2 / 12,500 ft^2 = 7
- Time to complete site inspection = 1.75 days (2 hours for every 12,500 ft^2)
  = $56/hour x 8 hours/day x 2 people
  = $896/day
- Radiation surveys of surface soil = $16,000/event ($1,000 for every 5,000 ft^2).

D3.7 COST REPORTING

D3.7.1 Summary of Cost

A summary of the present worth costs for each of the representative sites and each of the evaluated alternatives presented in Tables D-1 through D-42 is presented on Table D-65. In addition, Tables D-65 uses a set of ratios to generate present worth costs for the analogous sites under each representative site. The ratio methods used to generate the analogous site costs are alternative specific and are explained in the notes of Tables D-44 and D-45. As indicated in Section D3.2, Alternative 2 costs were developed for both representative and analogous sites. Therefore ratio calculations are not used for Alternative 2 on Table D-65.

In some cases, sites that are analogous to representative sites are more appropriately compared to another representative site because of the concentrations of the waste found on site. For example, 207-Z-Retention Basin is an analogous site to 216-Z-11. However, 216-Z-11 contains TRU waste and 207-Z-Retention Basin does not have TRU waste. Therefore, although Site 207-Z-Retention Basin is analogous to Site 216-Z-11, the cost for Site 207-Z-Retention Basin is calculated using Site 216-U-14 for Alternative 3 because of excavation volume similarities and Site 216-T-26 for Alternative 4 because of area similarities. Analogous sites whose costs are based on other representative sites are footnoted in Table D-65.

D3.7.2 Development of Minimum Costs

Occasionally a representative site is much larger than one or more of its analogous sites. In these situations, the difference in contaminant volume or site area between the representative site and analogous site is so large that the ratio cost for the analogous site is smaller than what would be considered a minimum cost to perform the alternative. For these situations, a minimum cost was developed for Alternatives 3, 4, and 5. As indicated in Section D3.2, Alternative 2 costs were developed for both representative and analogous sites. Therefore, the development of a minimum costs for Alternative 2 is not required. These minimum costs are based on the activities that must occur regardless of the sites contaminant volume or area. When the calculated cost for an analogous site (using ratios) falls below the minimum cost for the particular alternative, the minimum cost is then assigned to the analogous site. The following tables summarize the activities that are included in the minimum costs for each alternative. The non-discounted present worth minimum cost for Alternatives 4 and 5 is included at the end of each table. Non-discounted constant dollar costs demonstrate the impact of a discount rate on the total present value cost. The non-discounted costs are presented for comparison purposes only.

ALTERNATIVE 3 – REMOVAL, TREATMENT, AND DISPOSAL

Item	Quantity	UOM	Unit Cost	Extended Cost	Cost Plus Markups
Construction Oversight (Includes 1 RCT)	5	day	$1,720.00	$8,600	$119,069
RCT on Excavator and Decon Pad[1]	6	day	$448.00	$2,688	
Sampling (Overburden, LLW, Site Cert, QC)[2]	6	ea	$11,933.33	$71,600	
Sampling Crews[3]	2	day	$3,168.80	$6,338	
Transportation and Disposal	25	ea	$1,100.00	$27,500	
Equipment Mobilization/Demobilization	10	ea	$452.00	$4,520	$71,468
Personnel Mobilization/Demobilization	12	ea	$592.00	$7,104	
Haul Road - Gravel, 6" thick	880	sy	$7.36	$6,477	
Decontamination Pad[4]	1	ea	$2,844.42	$2,844	
Excavation[5]	2	day	$2,158.17	$4,316	
Restoration[6]	1	day	$7,509.62	$7,510	
Seeding	526	sy	$1.63	$857	
Support Personnel	5	day	$1,600.00	$8,000	
Post Construction Documents	160	hr	$50.00	$8,000	

Subtotal	$190,537
Contingency @ 25%	$47,634
Subtotal	$238,172

1 Includes 1 RCT on excavator for 2 days and 4 RCT on decon pad for 1 day.
2 Includes 2 air samples and 6 overburden, LLW, and site certification samples and 1 QC sample (21 total samples).
3 Includes air and soil/sediment sampling crew for 2 days each and a site certification sampling crew for 0.3 days.
4 Includes cost to construct decon pad, 2 laborers to run for 1 day, and decon water.
5 Includes equipment and labor cost for a water truck, excavator, and front-end loader.
6 Includes labor and equipment costs for a front-end loader and bulldozer on site, an excavator and front-end loader at the on-site borrow source, 5 dump trucks, and a water truck

ALTERNATIVE 4 - CAPPING

Item	Quantity	UOM	Unit Cost	Extended Cost	Cost Plus Markups
Construction Oversight (Includes 1 RCT)	10	Day	$1,720.00	$17,200	$19,780
Equipment Mobilization/Demobilization	11	Ea	$452.00	$4,972	$281,271
Personnel Mobilization/Demobilization	15	Ea	$592.00	$8,880	
Haul Road - Gravel, 6" thick	4,400	Sy	$7.36	$32,384	
Construct Decontamination Pad	1	Ea	$767.75	$768	
Mobilization/Demobilization of Crane	1	Ea	$10,600.00	$10,600	
Cap Construction[1]	10	Day	$7,783.60	$77,836	
Support Personnel	10	Day	$1,896.00	$18,960	
Labor (4 laborers @ $37/hour)	10	Day	$1,184.00	$11,840	
Post Construction Documents	160	Hr	$50.00	$8,000	

Subtotal	$301,051
Contingency @ 25%	$75,263
Subtotal	$376,313

Periodic Costs	150	Yr	$1,902.69	$285,403	$285,403

Total	$661,717
Non-discounted Total	$1,795,668

1 Includes equipment and labor cost for an excavator, five dump trucks, a front-end loader, a bulldozer, and a vibratory roller.

ALTERNATIVE 5 – REMOVAL, TREATMENT, AND DISPOSAL WITH CAPPING

Item	Quantity	UOM	Unit Cost	Extended Cost	Cost Plus Markups
Construction Oversight (Includes 1 RCT)	9	day	$1,720.00	$15,480	$100,643
RCT on Excavator and Decon Pad[1]	7	day	$448.00	$3,136	
Sampling (Overburden, LLW, QC)[2]	6	Ea	$6,933.33	$41,600	
Sampling Crews[3]	3	day	$3,068.00	$9,204	
Transportation and Disposal	25	Ea	$1,100.00	$27,500	
Equipment Mobilization/Demobilization	13	Ea	$452.00	$5,876	$166,170
Personnel Mobilization/Demobilization	15	Ea	$592.00	$8,880	
Haul Road - Gravel, 6" thick	4,400	Sy	$7.36	$32,384	
Decontamination Pad[4]	1	Ea	$8,779.42	$8,779	
Excavation[5]	2	day	$2,158.17	$4,316	
Dynamic Compaction[6]	1	Ls	$13,419.60	$13,420	
Restoration[7]	1	Ls	$11,964.01	$11,964	
Seeding	526	Sy	$1.63	$857	
Support Personnel	9	day	$1,600.00	$14,400	
Post Construction Documents	40	Hr	$50.00	$2,000	

Subtotal	$266,813
Contingency @ 25%	$66,703
Subtotal	$333,516

Periodic Costs	150	Yr	$2,357.43	$353,615	$353,615

Total	$687,131
Non-discounted Total	$2,083,217

1 Includes 1 RCT on excavator for 3 days and 4 RCT on decon pad for 1 day.
2 Includes 3 air samples and 6 overburden and LLW samples and 1 QC sample (16 total samples).
3 Includes air and soil/sediment sampling crew for 3 days each.
4 Includes cost to construct decon pad, 2 laborers to run for 1 day, and decon water.
5 Includes equipment and labor cost for a water truck, excavator, and front-end loader.
6 Includes mobilization and demobilization of crane and equipment and labor cost for a water truck and crane for 1 day.
7 Includes labor and equipment costs for a front-end loader, bulldozer, excavator, vibratory roller, dump trucks, and a water truck to restore/cap site and cost for material being purchased off site.

REFERENCES

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